ABANDONED MINE LAND INVENTORY

AND

HAZARD EVALUATION HANDBOOK

By

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DRAFT

FOREWORD

The U.S. Bureau of Mines produced this handbook in response to the increased concern by many groups, including land managing agencies, about the environmental and physical hazards and legal liabilities of abandoned mines. It sets forth guidance for the development of an abandoned mine land (AML) inventory and the subsequent investigation and evaluation of the environmental and physical hazards present on such lands. It is designed for use by land management and other agencies that are subject to regulations governing the mitigation of environmental and public safety hazards that exist on AML within their jurisdiction but who may be unfamiliar with mining and mineral processing.

Mines, mills, and smelters may be divided into two groups: operating (those with production) and non-operating (those without production). This manual addresses only the non-operating mines and mills. The term "abandoned mine land" is used herein as a generic term without specific intent or implication to any legal or political connotation on a State or national level. However, many agencies and institutions prefer to use the terms "inactive" or "inactive and abandoned mines" rather than simply "abandoned mines" because of the potential to reopen closed properties as economics or technologies change.

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ABBREVIATIONS USED IN THIS HANDBOOK

Units of Measure

cm	centimeter
cm/yr	centimeter per year
cps	count per second
ft	foot
gpm	gallon per minute
in	inch
in^3/gal	cubic inch per gallon
km	kilometer
mg/L	milligram per liter
m	meter
min	minute
mt	metric ton
pct	percent
sec	second
°	degree of arc

Acronyms

AML	abandoned mine land(s)
ANFO	ammonium nitrate and fuel oil
BLM	(U.S.) Bureau of Land Management
CERCLA	Comprehensive Environmental Response Compensation Liability Act
DMEA	Defense Minerals Exploration Administration
DOC	(U.S.) Department of Commerce
EPA	(U.S.) Environmental Protection Agency
GPS	global positioning system
IC	Information Circular, U.S. Bureau of Mines
IRS	Internal Revenue Service
MAS/MILS	Minerals Availability System/Minerals Industry Location System
MLA	Mineral Land Assessment, U.S. Bureau of Mines
MPF	Mineral Property Files
MRDS	Mineral Resource Data System, U.S. Geological Survey
MSHA	Mine Safety and Health Administration, U.S. Department of Labor
NPL	National Priorities List
OFR	open file report
PLS	public land survey
RI	Report of Investigation, U.S. Bureau of Mines
TDS	total dissolved solids
USBM	U.S. Bureau of Mines, Department of the Interior
USGS	U.S. Geological Survey, Department of the Interior
UTM	universal transverse mercator
WMR	War Minerals Report

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ABSTRACT

The purpose of an abandoned mine land (AML) inventory and investigation is to identify and assess AML sites and associated hazards. The term "abandoned mine land" (AML) is used throughout this handbook. However, many agencies and institutions prefer to use the terms "inactive" or "inactive and abandoned mines" rather than simply "abandoned mines" because of the potential to reopen closed properties as economics or technologies change.

This U.S. Bureau of Mines (USBM) handbook describes how to develop and conduct such an inventory and assessment using a four-step process. The focus is on hardrock (including industrial and non-mineral) sites. In the early part of the handbook and in Step I, specific things to consider during a reconnaissance of an AML site are described, as are the data required to adequately assess a site. In Step II, the environmental and physical hazards at each site on the AML inventory are initially assessed and ranked according to potential risk to the environment and human health. Following a site investigation involving the use of a standard data form (Step III), each site on the AML inventory is assigned a priority ranking (Step IV) on which to base site characterization or hazard mitigation.

Major hazards that may be present on abandoned mine lands are discussed in two broad categories: environmental and physical hazards. Environmental hazards include toxic substances, heavy metals, polychlorinated biphenyls, acids, petroleum products, asbestos, radioactive materials, sedimentation, and dust. Physical hazards include abandoned explosives, unstable structures, mechanical equipment, scrap materials, underground workings, open pits, highwalls, ditches, subsidence, waste piles, and impoundments.

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CHAPTER 1

INTRODUCTION

Government agencies, because of recently enacted regulations, face a rapidly expanding, costly liability for the cleanup of hazardous sites. This is particularly true for public lands containing abandoned mining and milling sites. The Environmental Protection Agency (EPA), in a 1985 report to Congress, estimated the total volume of existing mine wastes to be more than 45 billion mt. A 1991 report prepared for the Western Governors' Association indicates the total number of sites to be hundreds of thousands and the potential cost of remediation to be billions of dollars.

U.S. Bureau of Mines (USBM) records show that at least 200,000 mining-related sites, most abandoned or inactive, exist nationally. The Mineral Policy Center, in its "Burden of Gilt" publication, states that there are likely 557,650 sites. The obviously hazardous sites, especially those proximal to urban areas, have been targeted under the Comprehensive Environmental Response Compensation, and Liability Act of 1980 (CERCLA or Superfund). Of the more than 1,200 sites on the National Priorities List (NPL), 59 (4.9 pct) are directly related to mining. However, as described in the House Committee on Natural Resources' "Deep Pockets" report, of the remaining mine sites, those that deserve priority attention and, just as important, those which can be ignored, are largely unidentified. Most of these sites are in rural areas, often on or surrounded by public lands and thus the responsibility of Federal land-management agencies. In the absence of a clear understanding of the scope and severity of hazards associated with inactive and abandoned mine lands (AML), the public and Government agencies are very concerned about the true risks posed by these lands. This concern, and regulatory mandates, have prompted a need for detailed inventories of AML and analyses of AML hazards.

The purpose of this handbook, then, is to facilitate standardized, consistent AML inventories. It is probable that there will be a desire to complete an inventory of all sites in a short timeframe. It is also probable that many investigators will not have an extensive mineral and environmental science background. This handbook provides such an investigator with sufficient knowledge and guidance to be able to conduct an effective, efficient AML inventory and evaluate the environmental and public safety hazards present. It is not intended to be an in-depth source of information; an extensive bibliography is included in appendix J. Also, because coal mines have already been inventoried according to Office of Surface Mining directives and procedures, the handbook is focused on hardrock (including industrial and nonmetallic minerals) AML sites.

The AML inventory and evaluation process presented herein is designed to efficiently and accurately identify priority sites. It entails four steps: Step I--development of an AML database/list of sites using files, literature, databases, and other sources; Step II-selection of sites for one half-day field investigations; Step III- field investigation of selected sites using a standardized data reporting form; Step IV--identification of sites requiring future action.

Many Federal and State agencies have developed, or are in the process of developing data reporting forms. The data reporting forms presented in this handbook include those mine or mineral-related features that the Bureau feels to be of the most importance in an AML inventory. The Bureau is interested in working with other agencies and organizations in an effort to standardize data reporting forms.

While consistency among inventories is highly desirable, investigators can modify, augment, or supplement these steps and/or the data reporting forms to suit their own requirements, or incorporate portions in an already established system.

If AML investigators or members of their agency need additional copies of this handbook or assistance in assessing either physical or environmental hazards, please contact the Bureaus' Western Field Operations Center, Spokane, WA (509-353-2700); the Alaska Field Operations Center, Anchorage, AK (907) 271-2455; or the Intermountain Field Operations Center, Denver, CO, (303) 236-0421.

CHAPTER 2

MINERAL INDUSTRY OVERVIEW

A variety of mineral commodities and mining-milling situations may be encountered in an AML inventory-evaluation program. For those unfamiliar with mining or mineral processing, industry practices are summarized in this section (fig. 1), a glossary of commonly used terms is presented in appendix A, and a detailed discussion of four selected processing methods is included in appendix B.

Mineral commodities can be grouped into three categories: metallic minerals, nonmetallic (industrial) minerals, and solid energy fuels. Metallic minerals, commonly called "ores," consist of the precious metals (gold, silver), base metal sulfides (sulfides of copper, lead, zinc), and oxides of major metals (aluminum, iron, nickel). Nonmetallic minerals consist of minerals such as asbestos, calcite, dolomite, gypsum, and quartz that are not processed for the metals they contain. Rather, their value lies in their chemical and physical properties. Solid energy fuels include coal, tar sands, and uranium.

Mineral exploration is carried out by individual prospectors who hope to make a discovery they can develop or sell to a mining company, and by the exploration departments of small and large mining companies. Mineral exploration usually begins with an idea and follows a detailed plan. If surface information indicates a mineral deposit is present, a drilling program may be initiated to determine the shape, size, and grade of the deposit.

There are two basic ways in which minerals are mined--surface and underground. The selection of a mining method depends on the nature and location of the deposit and cost considerations.

Surface or open pit mining is used for large, near-surface deposits which have a low commodity value per unit of volume. Rock is drilled, blasted, loaded into trucks, and hauled to a facility where it is crushed and ground to a uniform size.

Underground mining methods are used when mineralized rock occurs deep beneath the Earth's surface. To reach the ore body, remove ore and waste, and provide ventilation, miners must excavate either a vertical shaft, a horizontal adit, or an inclined passageway. Within the ore deposit, horizontal passages called "drifts" and "crosscuts" are developed on several levels to access mining areas called "stopes"

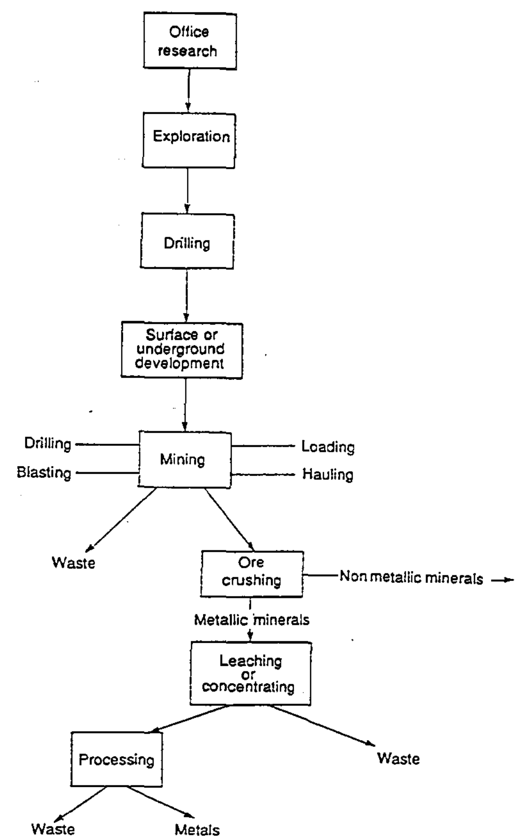

Figure 1.--Generalized mineral industry flowsheet.

(fig. 2). Blasted rock is hauled away from the stopes by trains, loaders, or trucks that may take it directly to the surface or transport it to a shaft where it is hoisted to the surface and sent to a crushing facility.

Nonmetallic minerals and solid energy fuels are, usually after crushing and cleaning, used as is in commodity-specific plants. At metal mines, crushed ore is treated by heap leaching or concentrating, depending on its grade. See appendix B for a discussion of ore leaching and concentration.

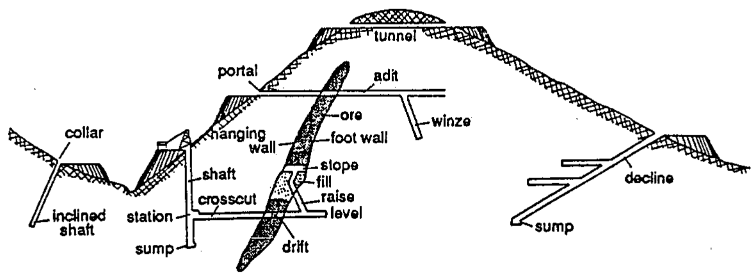

Figure 2.--Cross section of underground mine.

Ore to be leached is stacked on an impervious pad in large piles composed of many layers of crushed ore. Chemical solutions sprinkled on the ore percolate down, dissolving the metallic minerals. The metal-bearing solution is collected at the base of the pile and pumped to a processing plant where the metal is recovered from solution.

Nonleach ore is hauled to a mill where the metallic minerals are separated from the nonmetallic minerals and from each other by gravity or flotation methods. Flotation works by bubbling air through a mixture of crushed ore, water, and certain chemicals. Metallic minerals selectively attach themselves to the bubbles, float to the surface, and are skimmed off and dried. Mineral processing plants (mills) are not always located next to mines; they can be several kilometers apart. See appendix B for a discussion of mineral flotation.

Mineral concentrate produced by gravity or flotation is shipped to a processing plant where it is converted to metal in the form of bars, ingots, sheets, or wire. These metals then are used in the manufacture of finished products such as automobiles.

Waste materials left over from mining, crushing, leaching, concentrating, and processing are dumped or pumped in large piles or impoundments, or are recycled.

Abandoned mines (fig. 3), mills, waste dumps, tailings ponds, leach piles, and other related features can pose a threat to human health and the environment. The objective of an AML inventory is to document the presence or absence of physical and chemical hazards and to decide on future actions.

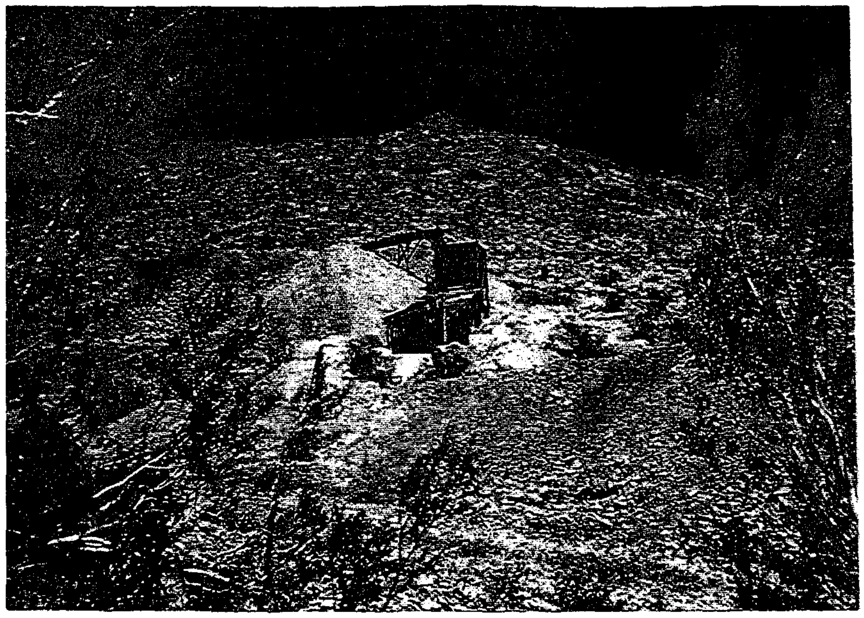

Figure 3.--Abandoned mine site.

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CHAPTER 3

POTENTIAL HAZARDS AT MINERAL SITES

ENVIRONMENTAL HAZARDS

A hazard is considered to exist if: (1) site conditions contribute to degradation of the environment or human health on or adjacent to the site, or (2) physical site conditions could lead to human injury or death. Appendix I provides a listing of AML site features and associated hazards.

Environmental hazards include, but are not limited to, the presence of toxic, corrosive, radioactive, or otherwise noxious metals, chemicals, or materials, or unusual environmental conditions resulting from mining and/or milling operations (fig. 4). The hazards, depending on severity, may or may not represent violations of environmental law. Physical hazards include, but are not limited to, unsafe structures, dangerous mechanical equipment, underground mine workings, concealed shafts or pits, and explosives.

Environmental Hazards Related to Minerals

Although minerals-related chemical hazards include many metals, certain metals currently are considered of critical significance according to EPA ecological risk assessment guidelines; these include lead (Pb), zinc (Zn), arsenic (As), and mercury (Hg). Lead and zinc commonly are referred to as "base metals," arsenic may be associated with gold deposits, and mercury may occur with either group. All occur naturally as a result of mineral deposition processes. Lead, zinc, and mercury also are of economic interest; arsenic usually is an unusable byproduct. These metals may be introduced into the environment through the natural process of erosion of mineral deposits or through mining and milling of these deposits. When introduced by the latter, metals or mineral decomposition products may be present in mine water, mine dump rock, mill tailings, or nearby soils or water bodies.

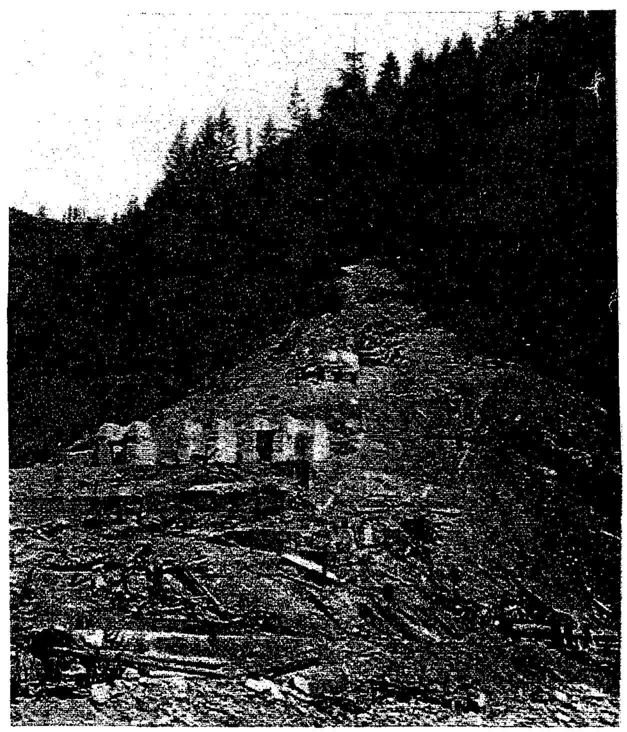

Figure 4.–Abandoned mill site.

Radioactive minerals can be found both at mines that produced radioactive minerals and at mines that produced other commodities. Radioactive minerals are quite soluble in water. Phosphate, while not hazardous, is commonly associated with radioactive minerals and heavy metals which may become liberated and/or concentrated during mining and processing.

Mining and milling operations generate two types of solid waste: mine waste and tailings (for a regulatory definition of mine wastes as hazardous substances, the reader is referred to 40 CFR 261).

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Mine waste is that material, which was removed from the ground during the excavation of underground workings, that cannot be processed economically, or overburden removed from placer deposits or open pit mines. Waste rock typically ranges from sand-size particles to boulders several meters in diameter. See figure 5 for an example of a waste dump.

Mill tailings, on the other hand, have a much different texture than waste rock (fig. 6). Tailings are the result of the milling process where ore is crushed to sand-size or smaller particles. Water and extraction chemicals may be added after grinding, and the resulting slurry is processed (flotation) to remove the ore minerals. The residual slurry is disposed of after the valuable minerals have been removed.

Figure 5.–Mine waste dump.

Past disposal methods have included deposition on the ground downhill from the mill or piping to an adjacent stream or settling pond.

The term "tailings" also is used in reference to to placer mining waste. As the valuable commodity (usually gold) is separated from gravel in the wash plant, waste material is discarded at the downstream discharge of the plant. In the case of non-dredge plants, the waste is stacked in a convenient location by earthmoving equipment, whereas in the case of floating dredge operations, tailings are ejected from the rear of the plant with a waste-stacking apparatus.

Figure 6.–Mill tailings pond.

Many mine and mill waste materials contain sulfides (metallic ions in combination with sulfur) which can, when exposed to air and moisture, generate sulfuric acid (H_2SO_4).

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The reaction between pyrite (iron sulfide), oxygen, and water is the primary acid producer, and the rate of this reaction can be accelerated significantly by the presence of a bacteria, *Thiobacillus ferroxidans*. The acid produced can dissolve base metal sulfides and release the metals to solution. The dissolved metals then can be transported by surface or ground water to the surrounding environment (fig. 7). Acidic, metal-bearing waters can be harmful to aquatic biota and other users. The often-associated deposition of iron oxide and iron oxyhydroxide sludges can fill or restrict flow in streams and cover the stream substrate used by aquatic animals and plants. Not all mine and mill wastes will generate acid water because the host rock containing the sulfides may be of a composition (primarily carbonates) that neutralizes any acids formed or pyrite may not be present in significant concentrations.

Figure 7.--Iron oxide stain on rocks in stream.

Environmental Hazards Related to Processing Chemicals

Mineral processing uses a variety of chemicals (reagents) for mineral recovery. Many of these chemicals have changed over time; those used years ago often have been replaced by new ones. In addition, the number of new reagents expands constantly. Because of this, the number of individual minerals-related processing reagents is too large to list individually. However, they may be listed by groups. Table 1 lists groups of reagents, the decade in which they were commonly used, and the mineral commodity groups for which they were used. If one knows enough about the history of an AML site, table 1 allows one to predict the reagents that might be expected at that site. If any of these reagents are still present on site, they may be found in old mill buildings, storage sheds, work shop areas, garbage dumps, or containers within waste piles.

Almost all reagents are EPA critical (a class of hazardous waste) in one sense or another. However, most processing reagents decompose over time when exposed to the natural elements. Hence they are unlikely to be found free in tailings except at recent milling operations or under unique conditions that cause them to somehow be encapsulated. Mercury is a notable exception as it is quite persistent.

Cyanide, also a mineral processing reagent, has a long history of use and is often of public concern. A detailed discussion of all the pertinent controlling factors and considerations is beyond the scope of this handbook; but, in general, pure cyanide will decompose in nature under oxidizing conditions. Under anaerobic (oxygen deficient) conditions, such as might be found in the interior of a tailings pile, cyanide may remain. Cyanide can be transported by water when pH is 7 or greater (alkaline). Cyanide can also form cyanide-metal complexes that are hazardous.

Table 1.--Historical use of "EPA Critical" mining chemicals for evaluation of environmental hazards of abandoned mine tailings

Period	Commodity					
	Iron	Sulfides	Gold	Uranium	Phosphate	Other industrial minerals
1920	alum	alum	Hg	-	alum	alum
1930	alum	xanthate pine oil alum	Hg	-	alum	alum
1940	alum pine oil NaCN alum	xanthate	Hg	-	alum	alum
1950	alum fatty acid fatty amines NaCN alum	xanthate thiocarbinilides pine oil pine oil alum	Hg NaCN xanthate	HCl H2SO4 NaHCO3	alum fatty acid	alum
1960	alum fatty acid fatty amines polyacrylamides pine oil NaCN alum polyacrylamides	xanthate thiocarbinilides thiocarbanates sulfhydrl anionics alum polyacrylamides	Hg NaCN xanthate pine oil	HCl h2SO4 NaHCO3 polyacrylamides	alum fatty acid polyacrylamides	alum polyacrylamides
1970	sulfhydryl anionics fatty acid fatty amines polyacrylamides alcohol frothers water glass dispersants alum polyacrylamides petroleum sulfonates alcohol frothers water glass dispersants	xanthate thiocarbinilides thiocarbanates sulfthydryl anionics pine oil NaCN sulfhydryl anionics water glass dispersants	thiocarbinilides NaCN xanthate pine oil alcohol frothers polyacrylamides	HCl H2SO4 NaHCO3 polyacrylamides	fatty amines fatty acids polyacrylamides alcolhol frothers	fatty amines fatty acids polyacrylamides
1980	sulfthydryl anionics fatty acid fatty amines polyacrylamides alcohol frothers water glass dispersants	xanthate thiocarbinilides thiocarbanates sulfthydryl anionics pine oil NaCN alum polyacrylamides petroleum sulfonates alcohol frothers	thiocarbinilides NaCN xanthate pine oil alcohol frothers polyacrylamides water glass dispersants	HCl H2SO4 NaHCO3 polyacrylamides	fatty amines fatty acids polyacrylamides alcolhol frothers	fatty amines fatty acids polyacrylamides

Other Chemical and Associated Hazards

Polychlorinated biphenyls (PCB's) are a carcinogenic class of manufactured chemicals. PCB's were first marketed in 1929 and have had a variety of applications in the electrical industry. Their most widespread use was as an additive to oils used to cool large electrical transformers (fig. 8) and capacitors (1).[1]

Figure 8.–Oil-cooled transformer.

Gasoline and diesel fuel, in addition to other petroleum products such as lubricating oil, hydraulic fluid, brake fluid, and grease, are essential to the operation of mine and mill equipment. Petroleum products may have been stored in cans, buckets, barrels, or above- or below-ground storage tanks. Maintenance shops and storage buildings are likely places to find petroleum products.

Asbestos derived from some asbestiform minerals can be hazardous to humans because of its fibrous nature and tendency to break into microscopic particles. Airborne fibers may accumulate in the lungs and irritate lung tissue. In recent years regulations have been enacted controlling the use of asbestos; but, prior to regulation, asbestos commonly was used for insulation around hot equipment, pipes, ducts, and as an additive to construction materials as a fire retardant.

Stream sedimentation can occur in and near AML sites as a result of the erosion of mine waste and tailings, or the erosion of any portion of the site where the natural hydrologic regime or vegetative cover has been disturbed. Sedimentation poses a threat to indigenous flora and fauna as well as water quality.

Blowing dust contributes to erosion of the site and may cause mobilization of contaminants contained in tailings piles and waste dumps, and the subsequent deposition of those contaminants in areas distal to the site.

PHYSICAL HAZARDS

Numerous types of physical hazards can be found within a single AML site. The hazards may include dangerous mine openings such as shafts and adits, highwalls, gloryholes, and subsidence pits. Other safety hazards include falling rocks, dangerous mine gases, dilapidated buildings and structures, mechanical and electrical equipment, explosives, unstable ground, and tram cables. The leading cause of injury or death at AML sites is by falling into mine openings. Despite a solid appearance, the ground surrounding mine openings is often composed of weak fractured rock that may suddenly break loose; always stay well back from the edge.

[1]Underlined numbers in parentheses refer to items in the list of references cited.

Underground Workings

Underground workings (portals, shafts, caved open stopes, caved raises, and ventilation raises) are the physical hazard of greatest concern. Entryways into abandoned underground workings can be extremely dangerous due to failure of support timbers by decay or collapse (fig. 9). Unsupported rock in and around these openings can suddenly collapse if disturbed. Interior workings may include vertical and/or inclined shafts and raises. These hazards may be difficult to see, especially when water-filled. In addition to the possibility of rock failure in underground workings, unstable explosives, vertical mine passages, or oxygen-deficient, toxic, or explosive gases that may exist in the workings can result in severe injury or death. A video on this subject, entitled "Stay out and stay alive," is available from the Utah Division of Oil, Gas, and Mining. UNDER NO CIRCUMSTANCES SHOULD UNTRAINED PERSONNEL ENTER UNDERGROUND WORKINGS.

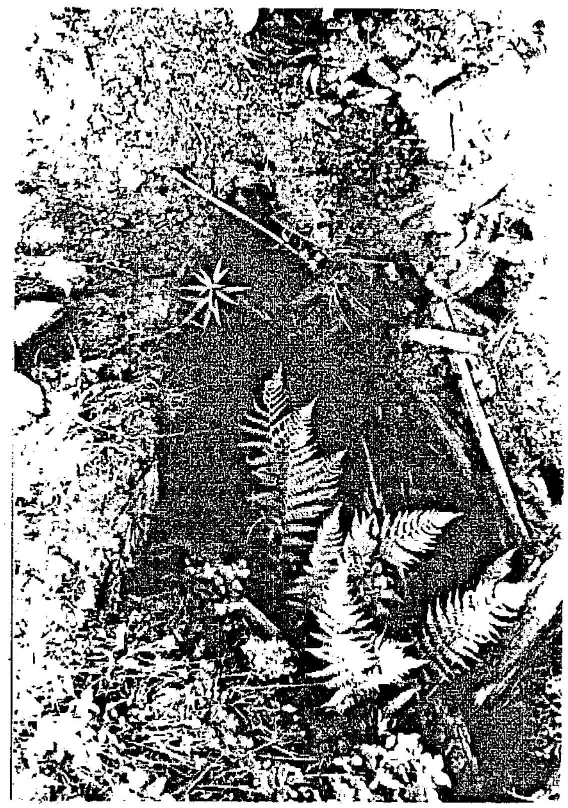

Figure 9.--Example of hazardous portal.

Highwalls, Pits, and Ditches

Highwalls are the steep slopes left by mining in large open pits, quarries, and sand and gravel pits. The risk of injury from a fall depends on the highwall height, slope, stability, and visibility. Small pits and trenches are not particularly hazardous unless they are concealed. The same is true for ditches except that ditches may have been used to route mine water, tailings, acid drainage, or other potentially contaminated fluid.

Subsidence Features

Ground subsidence can occur when underground openings collapse. The resulting subsidence features are dangerous. When an underground opening is the result of mining activity, the collapse can be the result of either the mining operation (block caving, sublevel caving, longwall mining, solution mining, etc.) or subsequent ground failure. Failure can be rapid or slow and triggered by surface activity. Underground failure may be expressed at the surface as an opening or a depression. Once subsidence has occurred, additional subsidence is likely.

Explosives and Blasting-Related Items

Materials used for blasting can be classified into three general groups: explosives, initiators, and accessories. Explosives are manufactured to be relatively insensitive and must have initiators to start the chemical reaction of the blast. Initiators, on the other hand, are very sensitive, even when fresh from the factory. Accessories include the electrical generators, gauges, and miscellaneous items needed for blasting.

The most widely used explosives in mining have been black powder, dynamite, and ammonium nitrate with fuel oil (ANFO). Black powder was extensively used in the 1880s but gradually was replaced by dynamite after the turn of the century (2). Black powder may be found in cans, kegs, or bags.

Dynamite is manufactured in the familiar stick form, which is approximately 20.3 cm (8 in) long and 2.5 cm (1 in) in diameter, and may be packed in wooden or cardboard boxes (fig. 10). Dynamite is composed of nitroglycerine and an inert filler, such as sawdust or clay, with the mixture wrapped in a paper roll. Nitroglycerine alone is very unstable, but when mixed with the filler it is relatively stable. Unfortunately, over a period of years, nitroglycerine can seep out of the filler (fig. 11) into the packing box or on to the underlying shelf, floor, or ground. <u>THE NITROGLYCERINE CAN EXPLODE IF DISTURBED: THIS IS AN EXTREMELY DANGEROUS SITUATION.</u>

Figure 10.–Old dynamite in cardboard container.

ANFO has gained popularity in mining since it was introduced in the mid-1930's. The two ingredients, ammonium nitrate and fuel oil, are relatively inert by themselves. Only when thoroughly mixed together in the correct proportions will they form a mixture that can cause a blast, and even then a strong explosive such as dynamite must be used to initiate the blast (2). ANFO may be found in metal or cardboard containers or paper bags.

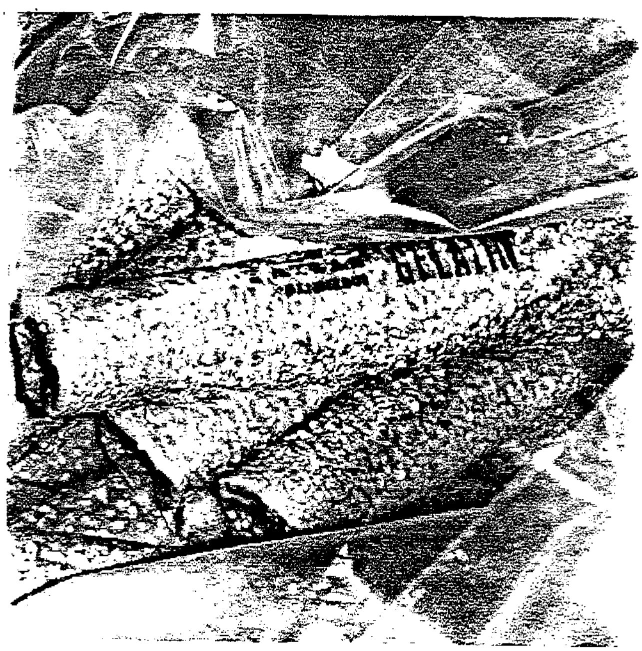

Figure 11.–Dynamite showing seepage and nitroglycerine "beads."

Initiators used with explosives include blasting caps and detonation cord. Blasting caps are manufactured as 2.5 cm (1 in) long metal tubes that are about the diameter of a pencil. Two types of blasting caps have been produced: electrical and nonelectrical. <u>BOTH CAN EXPLODE IF MISHANDLED AND THUS ARE EXTREMELY DANGEROUS</u>.

Electrical blasting caps have two thin, color-coded wires emerging from one end. During blasting operations, caps are connected with detonation wire to an electricity-generating blasting machine (fig. 12). Nonelectrical blasting caps are designed to be used with a time fuse–a fabric or plastic covered cord with black powder in the center. The blasting cap is attached to one end of the fuse and the opposite end is lit with a flame. Time fuse is relatively stable.

Like a time fuse, detonation cord also has a fabric or plastic outer layer and an inner core of explosive. Detonation cord must be initiated by a blasting cap and, when detonated, explodes along its entire length. Detonation cord is relatively stable.

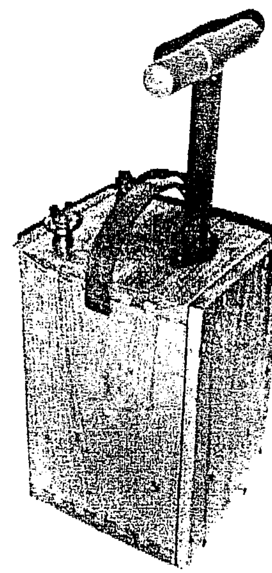

Figure 12.–30-cap blasting machine.

Buildings and Mechanical Equipment

The structural integrity of a mine or mill building is dependent upon the preparation of the foundation, the type of construction materials used, the age of the structure, and the climate. Although the availability of funds and materials were controlling factors, many buildings were intended to be temporary shelters and were constructed accordingly.

Abandoned buildings also can pose threats in ways unrelated to mining. Buildings offer excellent habitat to a variety of potentially dangerous animals such as snakes, scorpions, spiders, bees, wasps, hornets, and rodents. In recent years illegal drug manufacturers have discovered and taken advantage of the remoteness and existence of AML site buildings. The hazards of entering such buildings extend beyond the presence of reagents. Operations are frequently protected by armed guards and/or booby traps. If an illegal drug operation is discovered or suspected, vacate the site immediately and contact the proper authorities.

A variety of equipment can be found at an AML site and some can be hazardous. Equipment can include crushers, grinders, engines, boilers, flotation cells, screens, vats, trams, ore cars, conveyors, and bins (fig. 13). All can cause injury, especially if not well secured.

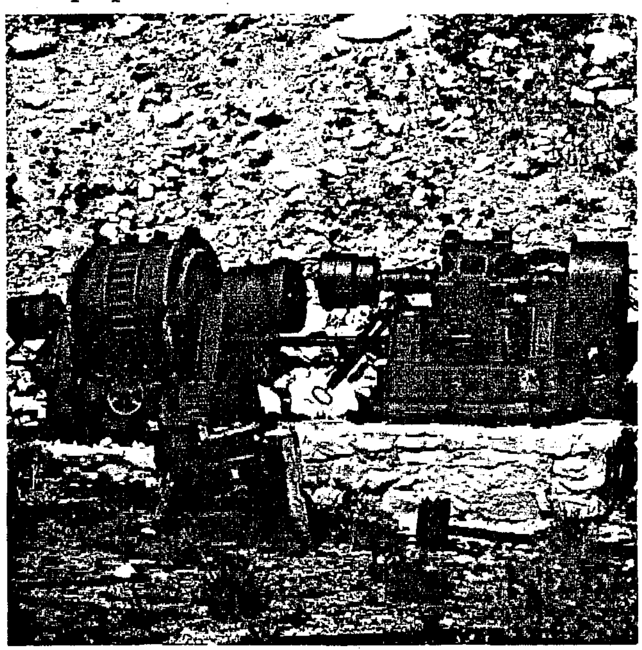

Figure 13.–Example of heavy equipment.

Wires and cables may be associated with equipment. They are dangerous if they can be contacted by aircraft.

Scrap Materials

AML sites often contain large quantities of scrap lumber, metal, and materials. Cuts and punctures can result, along with injuries due to tripping.

Impoundments

Impoundments often are used as a water supply for a mining or milling operation or as settling ponds for tailings slurries. Under certain circumstances, such as heavy rainfall or rotten timbers, the dam may fail and release water, sediment, or contaminants within the impoundment to the surroundings.

CHAPTER 4

AML INVENTORY

PURPOSE

AML inventories are conducted to determine the location of inactive and abandoned mines and to document the presence or absence of the hazards described previously. An inventory is the first phase of a multiphase process and includes four steps: two data steps and two screening steps. Each step is described in detail in upcoming sections.

AML PROCESS

Inventory Phase

Step I -> [Data]	Step II -> [Screen]	Step III -> [Data]	Step IV [Screen]		[Screen]
Develop initial site list.	Select field study sites.	Conduct field studies.	Identify -> future action sites.	Site Characterization Phase - >	Remediation Phase

Screening is important because it allows investigators to categorize AML sites as to their priority for future actions. It is also a tool for planning the allocation of personnel and financial resources. The resource cost per site escalates rapidly from one step or phase to the next. Screening allows planners to selectively reduce the number of sites to be considered in each ensuing step or phase. How conservatively or liberally the screening is done is a function of the risk tolerance of the concerned agency or office. Because physical hazards are likely to exist at the majority of sites (several hazardous features may exist at a single site) and are difficult to predict, most screens, including those in this handbook, are for environmental hazards. As a rough guide, in regards to environmental hazards, Bureau investigations to date (see AML Case Histories and Related Information in appendix J) indicate that, on average, 6 pct of the total number of sites in an area may require site characterization and 20 pct of these may require remediation.

With respect to the CERCLA process, the inventory phase is analogous to the combined Preliminary Assessment (PA) and Site Investigation (SI), and the site characterization phase is analogous to the Remedial Investigation and Feasibility Study (RI/FS). Remediation is the same for both processes.

The proactive application of the AML process should prevent all but the worst sites from being investigated under the CERCLA process. For an average site (a broad range exists), the costs for the three phases, inventory, site characterization, and remediation, are shown below. Note that travel costs, which are quite variable, are not included. Under the CERCLA process, costs for these phases would be tens of thousands, hundreds of thousands, and millions of dollars, respectively.

	Personnel	Financial
Inventory:		
Pre-field:	10 sites/day	Salary - 1 technician
Field:	1 site/day	Salary - 1 technician
Site Characterization:		
Field:	1 site/3 weeks	Salary - 3 specialists Samples - $10 to $250 each
Post-field:	1 site/26 weeks	Salary - 2 specialists
Remediation:		
Pre-field:	1 site/10 weeks	Salary - 3 specialists
Field:	1 site/2 weeks	Salary - 3 specialists Heavy equipment rental Salary - equipment operators Supplies

A critical aspect of the inventory process is collection of comparable site-specific data in a consistent manner. This is best accomplished by using a standardized form. An AML inventory form is provided in this handbook (appendix C). The form is designed to work with all types of AML sites and contains both pre-field and field data. The next four sections of this handbook are devoted to explaining what pre-field data to collect and record on the form and how to acquire it, a procedure to screen the pre-field data, what field data to collect and record on the form, and a means to evaluate the field data.

CHAPTER 5

STEP I--DEVELOP A LISTING OF AML SITES

The first step in the AML inventory/evaluation process consists of amassing pre-field site data, recording the data on Part I (the pre-field section) of the AML Inventory form referred to in the previous section, creating a computer file to store the data, and developing a listing of AML sites. There are a number of sources of information available to accomplish this step, some better than others, some more available than others.

It is important to note that several sources of information should be consulted to develop the initial list of sites. It is highly unlikely that any single source will be adequate to provide the necessary AML information. Using as many information sources as possible to compile the initial list of AML sites can increase the effectiveness and reduce the cost of any subsequent field investigation activities. For example, the USBMs Minerals Availability System/Mineral Industry Location System (MAS/MILS) database (see discussion under Information Sources, U.S. Bureau of Mines) can readily be used to identify mining sites. MAS/MILS is unique in that it contains information that can be very useful for screening sites for potential environmental hazards. This type of information cannot be determined from topographic maps. However, because MAS/MILS is a site data base, it is not intended to be a comprehensive information source on individual mine features (shafts, adits, prospect pits, structures, etc.) that may represent potential physical hazards at a site. While MAS/MILS points the user to the sites that may contain physical hazards, other information sources should be consulted to begin identifying the potentially hazardous features themselves. Those interested in detailed information on individual features are encouraged to use MAS/MILS in conjunction with USBM Mineral Property Files (MPF) (described below) and U.S. Geological Survey (USGS) 15- and 7.5-min topographic maps. Topographic maps are discussed later in this chapter and in appendix D.

SOURCES OF INFORMATION

A vast body of mine and minerals-related information has been collected and recorded. The major portion of this information resides in Federal, State, and local governmental institutions and agencies. Information sources are numerous and widespread and could present an AML investigator, often working under stringent time and funding constraints, with a challenge to acquire as much quality information as possible within these constraints. The following sections discuss the major sources of information available to the AML investigator; other less known sources are briefly mentioned.

U.S. Bureau of Mines (USBM)

Since its creation in 1910, the USBM has documented, tracked, investigated, and reported on thousands of domestic mines and minerals-related activities. The USBM is a major minerals research and information agency which has principal Federal responsibility for collecting, interpreting, and analyzing information involving mineral resources and the production, consumption, and recycling of mineral materials. For these reasons, the USBM is probably the best single source of information with regard to abandoned mine land identification and evaluation.

The following sections describe some of the most important and useful (from an AML perspective) sources of information within the USBM. Because of the volume of information available, the AML investigator probably will not need to, or have sufficient time to, refer to all of the references discussed below. The selection of information sources will be based on project time constraints and the availability of the references.

Minerals Availability System/Mineral Industry Location System (MAS/MILS)

Mine and minerals-related information derived from Federal, State, local, and private sources, has been compiled and entered into the Bureaus' MAS computer database. Of prime interest to an AML investigator is MILS, the locational subset of the larger MAS database. MAS/MILS locates and provides information on mineral industry sites throughout the world. These mineral industry sites or "mineral industry locations" include metallic and nonmetallic occurrences, prospects, mines (both past and present producers), geothermal wells, and mineral processing plants such as mills, smelters, and refineries. Currently, more than 200,000 domestic mineral industry locations are resident in MAS/MILS. Mineral locations for the State of Nevada are shown in figure 14, a density plot wherein each MAS/MILS location is represented by a single dot.

It must be pointed out that MAS/MILS is a database of mineral-related sites, not features. Therefore, a single MAS/MILS site (location) may represent one or more features such as shafts, adits, pits, highwalls, etc.

MAS/MILS data are typically obtained as paper printouts; however, in some cases the data may be available on genetic tape or diskettes. Refer to appendix F for information on how to obtain MAS/MILS and other USBM data.

Since the majority of MAS/MILS entries are reported from the body of minerals-related literature, MAS/MILS data coverage may range from basic locational, commodity, and bibliographic information to complete property descriptions. The following basic data always are present on a MAS/MILS printout:

- Deposit name.
- The State in which the property is located.
- The county in which the property is located.
- The 10-digit sequence number.
- A valid latitude and longitude.

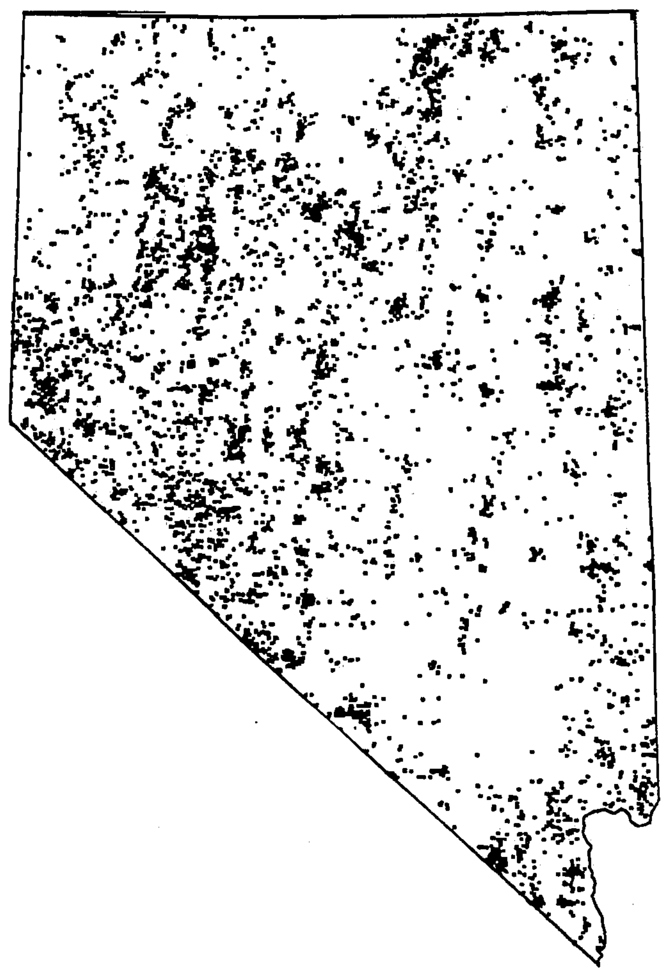

Figure 14.–Density plot of MILS locations in the State of Nevada.

- At least one mineral commodity.

Mineral Property Files

The USBM maintains extensive mineral property files (MPF) for both producing and past producing mining operations. In part, the files contain proprietary information such as ore reserves and capital and operating cost data that cannot be disclosed except with the owner's written permission. However, the files may contain information of a nonconfidential nature that would be of value to an AML investigator. Specific information such as extent and number of workings (shafts, adits, declines, etc.), milling methods (an indicator of what chemicals may have been used), ore and waste minerals, years of operation, among others, may be available. As MAS/MILS entries describe mineral-related sites as a single point location, data in mineral property files commonly describe many of the development features associated with a particular site.

Mineral Land Assessment (MLA) Reports

The Wilderness Act of 1964, the Federal Land Policy and Management Act of 1976, and other related acts require the USBM and the USGS to conduct mineral assessments of public lands considered for inclusion in the National Wilderness Preservation System. The USBM conducts field surveys to support multiple-use management of Federal lands with mineral resource information. Descriptions of these studies are published in the form of USBM Special Publications and open-file reports (OFR) and often are summarized in joint USBM/USGS reports published by the USGS. The reports represent a valuable source of information for the AML investigator.

Alaska Mining Claims Information System

An extensive listing of Alaska mining claims and other information helpful to the AML investigator is available through the Alaska Field Operations Center. Although the presence of a mining claim does not necessarily indicate the presence of an abandoned mine, the system references claims filed in the past that may have been developed or gone into production and may now be abandoned. Refer to appendix F for the Center's address and telephone number.

War Minerals Reports (WMR)

During World War II, the USBM and other Federal agencies engaged in mineral exploration programs and assisted in the development of mines and mineral processing facilities as part of the war effort. The results of the exploration and development programs were compiled in a series of reports, copies of which may be available through USBM Field Operations Centers. WMRs may contain information pertaining to borehole drilling, extent of workings, geology, mineralogy, mineral processing procedures, and other data of value to an AML investigator.

Defense Minerals Exploration Administration (DMEA) Reports

In the late 1950's and early 1960's, the Federal Government granted loans to individuals and corporations for the exploration and development of strategic mineral resources. As with the WMR, a series of reports was issued that reported on the progress of the exploration and development at various mines and prospects. These reports, known as DMEA reports, although generally fiscal in nature, often included incidental information pertaining to resources, minerals, extent of workings, borehole results, etc. DMEA reports are considered proprietary and require written permission of the property owner before disclosure. However, as with the MPF, some nonconfidential information may be available to an AML investigator. DMEA reports may be obtained through selected USBM or USGS offices.

Information Circulars (IC)

The USBM IC series is an excellent source of information including surveys of mineral resources and related mining and milling activities, compilations of historical and statistical data on minerals, and bibliographies. Detailed reports of minerals-related activities for an entire State, for a county or counties within a State, or local mining districts also are found in this series.

Additional USBM sources of information include Reports of Investigation (RI), Bulletins, mineral commodity reports, Minerals Yearbooks, OFRs, and special publications.

U.S. Geological Survey (USGS)

The USGS collects, compiles, analyzes, and publishes a great volume of geological information in its Bulletins; Professional Papers; Water Supply Papers; Circulars; Memoirs; topographic, geologic, and hydrographic maps; reports; unpublished file data; OFRs; and miscellaneous publications. In addition, personal journals, notes, unpublished reports, and other sources of information may be available at local USGS offices.

Of particular interest to the AML investigator are the USGS Annual Reports. The reports date from before the turn of the century and are an excellent source of historical information on past mining and milling operations.

USGS Mineral Resource Data System (MRDS)

The USGS also maintains a computer-based file of mineral occurrences, mines, prospects, etc. The Mineral Resource Data System (MRDS) may include information that complements or augments data resident in MAS/MILS and is a good source of information for the AML investigator. Moreover, MRDS may list mines and prospects not yet entered into MAS/MILS. Similar to MAS/MILS, MRDS is a site or location based system; each site may represent one or many features.

For information pertaining to MRDS and the procedure to obtain MRDS printouts and other USGS information, contact the USGS offices in Denver, CO; Spokane, WA; Tucson, AZ; or Reston, VA.

Topographic maps

The USGS creates and sells topographic maps which are available in several map series at a number of scales. Perhaps the most useful map series is the 7.5 minute quadrangle maps that may show many features associated with individual mining sites (shafts, adits, pits, etc.). For this reason, topographic maps are very useful for determining the likelihood of physical hazards. The older fifteen minute maps have been phased out by the survey and are no longer sold. However, these maps may contain information and display features not shown on the newer 7,5-minute maps. Appendix D describes topographic maps in greater detail.

Bureau of Land Management (BLM)

BLM sources of information include reports, files, records, notes, memoirs, and databases. Of particular interest to the AML investigator are the mining claim records, mineral survey records, mineral reports, lease information, mineral materials sales contracts, notices and plans of operation, and Case Recordation/On-Line Recordation Case Access (ORCA) database. District or local BLM office files may also provide useful AML information.

Environmental Protection Agency (EPA) and other Federal Sources

Possible sources of information germane to an AML evaluation include EPA's CERCLIS (a computerized inventory of potential hazardous waste sites) and Preliminary Assessment (PA) and focused Site Inspection (SI) files.

Other mines and mineral-related information useful in a literature search may be available through the following Departments or agencies:

- Department of Energy (DOE) reports;
- Office of Surface Mining (OSM);
- Mine Safety and Health Administration (MSHA);
- National Archives (NA);
- Library of Congress (LC);
- U.S. Department of Agriculture, Forest Service
- U.S. Departments of Commerce (DOC), Labor (DOL), and Defense (DOD);
- Internal Revenue Service (IRS).

State and Local Governments

Mining-related information often is available at State mining bureaus or departments of geology, historical societies, offices of the State mining inspector, State AML offices, State Departments of Ecology, Public Health and Safety offices, agencies with permitting or licensing responsibilities, highway departments, utilities commissions, libraries, and museums.

An excellent source of information on State hardrock AML programs is the joint report drafted by the Colorado Center for Environmental Management and the USBM. The 2-volume document, entitled "Inactive and Abandoned Noncoal Mine Inventory and Reclamation: A Status Report on 19 States," reports on ongoing and completed AML efforts in 19 states. Additionally, the document lists names, telephone numbers, and street and mailing addresses of principal environmental/AML agencies and agency contacts that may provide valuable information to the AML investigator. The list is included in this handbook as appendix K. The report is available for inspection at the Western Field Operations Center, Spokane, WA and the Intermountain Field Operations Center, Denver CO.

Local government sources include records of the county or city clerk, county and city tax assessors, highway and road departments, public utilities, libraries, and agencies with permitting or licensing responsibilities.

Private Sector

Business and nonprofit organization sources of information include mining and/or mineral exploration companies, historical societies and museums, industry and/or trade associations, mining consultants, etc. Commercial databases such as DIALOG and GEOREF[2] provide important information and references. Personal interviews with Federal, State and local government personnel, claim owners, miners, and other local citizens often yields valuable information not found in a literature search. Much of the interview process can be done from the office by telephone making the process more cost- and time-efficient.

Educational Institutions

Sources of information may include, but are not limited to, college and university departments of geology, mining, geophysics, geochemistry, hydrology, history, economics, social science, and their respective libraries. University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, maintains a clearinghouse for doctoral dissertations that may contain locational, rock, mineral, historical, and other information of interest to an AML investigator.

Aerial and satellite photography and imagery

Certain information on AML sites can be determined from aerial and satellite photography. Aerial photography, which generally has greater resolution than commercially available satellite images, can provide the location of mining sites and some features, and the approximate area of land disturbance by mining, dumps, and tailings ponds. Because satellite images have lower resolution, site information is limited to larger sites and features. Appendix L contains a more detailed description of the types of photographs and imagery available.

USING THE AML INVENTORY FORM--RECORDING BASIC AML SITE INFORMATION

Step I is best accomplished through a series of five intermediate steps, or **tasks**. Briefly, the tasks include:

Task 1. Area delineation and map acquisition.

Task 2. Acquire MAS/MILS data--record on AML Inventory Form, Part I-Pre-field data. The USBM MAS/MILS system is described in detail in Task 2.

Task 3. Map data. Develop site numbering system.

Task 4. If a large number of sites is anticipated, establish a computer file.

Task 5. Literature search.

The completion of Tasks 1-5 will result in a number of AML Inventory Forms on which pre-field site data have been recorded, a computer file of AML sites, and a listing of AML sites for analysis in Step II. Each task of Step I is described in detail in the following sections.

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[2]Use of trade or corporate names herein does not constitute endorsement by the U.S. Bureau of Mines.

Task 1–Area Delineation and Map Acquisition

The first task of Step I consists of delineating the area of interest on topographic maps. A brief discussion of topographic maps, their use, and where they may be obtained is presented in appendix D. It is always good practice to use the largest scale maps available. However, if the area under investigation is extensive, for example a large portion of a national forest, it may first be necessary to mark off the boundaries of the study area on a smaller scale map such as one or more of the 1:250,000 (1° by 2°) map series. Then, using the appropriate index for the particular 1:250,000 map (available through most USGS map outlets), determine the names of the large-scale maps (30-min x 60-min, 15 min, 7.5 x 15 min, or 7.5 min) within the study area. Once this determination is made, the appropriate maps should be acquired through the USGS Map Sales offices.

Task 2–Acquire MAS/MILS Data–Record Data on AML Form

Task 2 entails the acquisition of MAS/MILS data and entering pertinent information on the AML pre-field form. This is particularly important in that it establishes the framework and provides important property references for the subsequent literature search which, in turn, provides additional data for the screening processes described in Step II (pre-field data screen) and Step IV (post-field data screen). Appendix F provides information on how and where to obtain MAS/MILS information.

The following discussion describes the data fields in MAS/MILS that are germane to an AML investigation (fig. 15). Underlined numbers in parentheses following particular data fields relate the data of a specific field to specific line items on the AML pre-field form (fig. 16).

DATE GENERATED: APR 27, 1993

MINERALS AVAILABILITY SYSTEM
DEPOSIT LISTING

PAGE 1

1 DEPOSIT NAME: GRIZZLY BEAR

1 SEQUENCE NUMBER: 0160799203

>>>> MILS - TABLE <<<<
(GENERAL LOCATION INFORMATION)

3 STATE: IDAHO
3 COUNTY: SHOSHONE
4 TYPE OF OPERATION: UNDERGROUND
4 CURRENT STATUS: PAST PRODUCER
3 LATITUDE: N 47DEG 40MIN 22SEC
LONGITUDE: W 116DEG 14MIN 45SEC
UTM - ZONE: 11
HEMISPHERE: NORTHERN
NORTHING: 5279988
EASTING: 556613
POINT OF REFERENCE: MAIN ENT
PRECISION: 100 METERS
3 ELEVATION: 1000 METERS
PRECISION: 10 METERS
PROPERTY FILE REPORT DATE:

YEAR FIELD CHECKED: 1990
3 QUADRANGLE: SPOKANE

MILS EVALUATOR: KAUFFMAN

DATUM OF ELEVATION: SEA LEVEL
3 MAP NAME: KELLOGG
SCALE: 15 MIN
DOMAIN: PRIVATE
2 TYPE OF MINERAL HOLDINGS:
LOCATED CLAIM
PATENTED

MINE MAP REPOSITORY: W
TYPE OF EVALUATION: L
DATE LAST REVIEWED:
YEAR OF INFORMATION ENTRY: 1993
MAINTAINING FIELD CENTER:
WESTERN
MINERAL PROPERTY FILE: 99.9

MINES IDENTIFICATION:
GEOLOGICAL SURVEY SYSTEM: W019500
DATE LAST MODIFICATION:
APR 27, 1993
LAST DEPOSIT MODIFICATION:
APR 27, 1993
CONTRACTOR:

--PUBLIC LAND SURVEY--

PRINCIPAL MERIDIAN: 3
BOISE
TOWNSHIP: 048 N
RANGE: 002 E
SECTION: 02
SECTION SUBDIVISION: 3
NWSENE
SURVEY STATUS: SURVEY

TYPE OF PLANT:
PLANT IDENTIFIER:
MLA STUDY AREA: NO

PREDOMINANT MINING METHOD

4 PREDOMINANT MILLING METHOD

PREDOMINANT POST MILL PROCESSING METHOD

(GEOGRAPHICAL INFORMATION)

3 MINING DISTRICT: YREKA
*DISTANCE OF ROAD NEEDED: NONE
*DISTANCE TO ADEQUATE WATER SUPPLY: SITE
*DISTANCE TO ADEQUATE ELECTRICAL POWER SUPPLY: SITE
TOPOGRAPHY: V RUGGED
4 ANNUAL PRECIPITATION (IN CM) AND DISTRIBUTION: 90.0 :WINTER
*(IN KILOMETERS)

VEGETATION: CONIFERS
SOIL TEXTURE: UNKNOWN
PRIMARY LAND USE: MINERAL
WORKING SEASON: ALL YR
LABOR AVAILIBILTY: UNKNOWN
CLIMATE: COOL

(HISTORICAL INFORMATION)

DISCOVERY METHOD:

YEAR OF DISCOVERY: 1900

YEAR OF INITIAL PRODUCTION: 1912

YEAR OF LAST PRODUCTION: 1955

>>>>> COMMODITY - TABLE <<<<<

RECORD NUMBER	COMMODITY	MODIFIER	MARKETABILITY	COMMODITY CLASSIFICATION CODE	INDUSTRY REPORT CODE	STANDARD INDUSTRIAL CODE	SAS	DATE OF LAST MODIFICATION
4 01	LEAD	SULFIDE	RECOVERABLE	SULFIDE/SULFATE	METALLIC			APR 27, 1993
02	ZINC	SULFIDE	RECOVERABLE	SULFIDE/SULFATE	METALLIC			APR 27, 1993
03	SILVER		RECOVERABLE	ELEMENT	PRECIOUS METALS			APR 27, 1993
04	COPPER	SULFIDE		SULFIDE/SULFATE	METALLIC			APR 27, 1993
05	GOLD	LODE		ELEMENT	PRECIOUS METALS			APR 27, 1993

>>>> NAMES(ALTERNATE) - TABLE <<<<

1 01 BEAR MINE
02 GRIZZLY NO. 1 AND NO. 2
03 GRIZZLY

Figure 15.--MAS/MILS printout showing supplementary data.

DEPOSIT NAME: GRIZZLY BEAR SEQUENCE NUMBER: 0160799203

>>>> OWNERSHIP - TABLE <<<<

	RECORD NO.	NAME OF OWNER	STATUS	PERCENT OF OWNERSHIP	LOCATION OF HOME OFFICE	YEAR OF INFORM.	DATE OF LAST MODIFICATION
2 —	01	BLACK BEAR MINING COMPANY	UNKNOWN	%	USA COLORADO	1975	APR 27, 1993

Figure 15.--MAS/MILS printout showing supplementary data.--Continued

DATE GENERATED: APR 27, 1993 — MINERALS AVAILABILITY SYSTEM DEPOSIT LISTING — PAGE 3

DEPOSIT NAME: GRIZZLY BEAR — SEQUENCE NUMBER: 0160799203

>>>> HISTORY OF EXPLORATION <<<<

RECORD NO.	METHOD EMPLOYED	EXTENT EMPLOYED	SUPPORT OF EVALUATION	YEAR OF WORK	STATUS	YEAR OF INFORMATION
01	GEOCHEMICAL			1971	PRIOR TO	1975
02	TRENCHING			1949		1975
03	CORE DRILLING			1949		1975

>>>>> GEOMETRY - TABLE <<<<<

MATRIX NUMBER: 1 COLUMN NUMBER: DATE LAST MODIFICATION: APR 27, 1993

TYPE OF ORE BODY	SHAPE OF ORE BODY	TYPE OF WALLROCK ALTERATION	DEGREE OF WALL-ROCK ALTERATION	MODE OF ORIGIN	ORE CONTROLS
REPLACEMENT	TABULAR	BLEACHING	MODERATE	METAMORPHISM	FAULTING
FISSURE VEIN		SERICITIC		HYDROTHERMAL	FRACTURING
SHEAR ZONE					

STRIKE AND DIP OF MINERALIZED ZONE: N65W:75S

DEPTH TO MINERALIZATION (IN METERS)		THICKNESS OF UNCONSOLIDATED MATERIAL (IN METERS)		AVERAGE DIMENSIONS OF MINERALIZATION (IN METERS)		SURFACE AREA
AVERAGE:		AVERAGE:		LENGTH:	458.0	TOTAL:
MINIMUM:	.0	MINIMUM:	.0	WIDTH:	610.0	FUTURE:
				THICKNESS:	305.0	PREVIOUS:
						RECLAIMED:

>>>>> LITHOLOGY - TABLE <<<<<

MATRIX NUMBER: 0 RECORD NUMBER: 1

FORMATION NAME: INTRUSIVE DIKES
AGE OF FORMATION: TERT
DENSITY (IN SITU):

RELATIONSHIP OF MINERALIZATION TO DEFORMATION: UNKNOWN
DEFORMATION DESCRIPTION: UNKNOWN
AGE OF DEFORMATION:

Figure 15.--MAS/MILS printout showing supplementary data.--Continued

DEPOSIT NAME: GRIZZLY BEAR SEQUENCE NUMBER: 0160799203

>>>>> LITHOLOGY - TABLE <<<<<

MATRIX NUMBER: 0 RECORD NUMBER: 9

FORMATION NAME: PRICHARD FORMATION
AGE OF FORMATION: PRECAM
DENSITY (IN SITU):

RELATIONSHIP OF MINERALIZATION TO DEFORMATION: COMPLEX
DEFORMATION DESCRIPTION:
AGE OF DEFORMATION:

>>>>> MINERALS - TABLE <<<<<

4-

MAT #	REC NO.	AGE OF MINERALIZATION	OVERALL GRAIN SIZE	NAME	CLASS	GRAIN SIZE	AMOUNT	UNITS
	01	>CRET	VARIABLE	SPHALERITE	SULFIDES			
	02	>CRET	VARIABLE	GALENA	SULFIDES			
	03	>CRET	VARIABLE	CHALCOPYRITE	SULFIDES			
	04	>CRET	VARIABLE	PYRRHOTITE	SULFIDES			
	05	>CRET	VARIABLE	ARSENOPYRITE	SULFIDES			
	11	>CRET	VARIABLE	PYRITE	SULFIDES			
	12	>CRET	VARIABLE	SIDERITE	CARBONATES			
	13	>CRET	VARIABLE	ANKERITE	CARBONATES			
	14	>CRET	VARIABLE	QUARTZ	FORMS OF SIO2			
	15	>CRET	VARIABLE	CALCITE	CARBONATES			

>>>>> BIBLIOGRAPHY - TABLE <<<<<

SET REFERENCE	LINE NO.	
	001	ARNOLD,COLEMAN,FRYKLUND 1962 ECON GEOL V 57 NO 8 P 1163-1174
	002	US BUREAU OF MINES INFO CIRC 7560 BUTNER 1950 11P
	003	FRYKLUND (WITH A SECTION BY WEIS) 1964 USGS PROF PAPER 445
	004	JONES 1920 USGS BULL 710-A P 1-36
	005	UMPLEBY AND JONES 1923 USGS BULL 732 156P
	006	FORRESTER 1945 USGS OP-FILE MAPS: MAPS OF HIGHLAND-SURPRISE
	007	FORRESTER AND NELSON 1945 USGS OP-FILE REP: PB-ZN DEP PINE C
	008	FRYKLUND AND HARNER 1955 ECON GEOL VOL 50 NO 3 P 339-344
	009	HOBBS AND OTHERS 1965 USGS PROF PAPER 478
	010	SHANNON 1923 US NATL MUSEUM BULL 131 P 98-100

Figure 15.--MAS/MILS printout showing supplementary data.--Continued

U. S. Bureau of Mines
AML INVENTORY FORM EVALUATOR J. DOE DRAFT
Part I - Pre-Field Data (Side 1) PAGE 1 OF

SITE NUMBER Ø16Ø7992Ø3 DATE OF INVESTIGATION 9/25/93

1) PROPERTY NAME: Grizzly Bear

Alternate Names: Bear Mine, Grizzly #1, 2, Grizzly

MILS Sequence No. Ø16Ø799203 MRDS No. W0195ØØ

BOM Mineral Property File No. 99.9

State ID No. EPA ID No.

2) OWNERSHIP: What is the current ownership of the site? Check one.

Federal [ ] Indian [ ] State [ ] County [ ] Municipal [ ] Private/Patented [✓]

Unknown [ ] Other

If the owner is known, fill in the following information.

Name or Agency: Black Bear Mining Company

Address: Colorado

Telephone Number: — - — - —

Ownership includes Surface only [ ] Minerals only [ ] Both [ ]

3) LOCATION DATA: Fill in location information as available.

State: Idaho County: Shoshone

Township: Ø48 (N) S Range: ØØ2 (E) W Section: Ø2

Section Subdivision: NWSENE Meridian: Boise

Latitude: N47°4Ø'22" Longitude: W116°14'45"

UTM Zone: 11 Northing: 5277968 Easting: 556613

Elevation: 10Ø6 Specify units for elevation. Feet [ ] Meters [X]

Map Name: Kellogg Map Scale: 15 MIN

1:250,000 Quadrangle: Spokane

Mining District: Yreka

Approximate area of site Measured in Square feet [ ] Acres [ ] Hectares [ ]

4) HISTORICAL DATA: Check all that apply.

Type of Operation:

Surface [ ] Underground [X] Surface-Underground [ ] Mineral Location [ ] Placer [ ]

Prospect [ ] Dredge [ ] Processing Plant [ ] Well [ ] Unknown [ ] No Data [ ]

Status of Operation:

Past Producer [X] Explored Prospect [ ] Raw Prospect [ ] Unknown [ ]

Developed Prospect (greater than 300 meters of workings) [ ]

Figure 16.--AML data inventory form (pre -field section only)

DRAFT

EVALUATOR J. DOE

PAGE 2 OF

SITE NUMBER 0160799203

DATE OF INVESTIGATION 9/25/93

4) HISTORICAL DATA (Continued.) Check all that apply.

Commodities:

Arsenic [ ] Cadmium [ ] Copper [X] Lead [X] Mercury [ ] Zinc [X]

Other (specify) Gold, Silver

Commodity Groups:

Metals [X] Coal [ ] Oil and Gas [ ] Uranium or Geothermal [ ]
Industrial Minerals [ ] Sand and Gravel [ ] Non-Energy Leasable [ ]

Other (specify)

Acid Producers or Indicator Minerals:

Arsenopyrite [X] Chalcopyrite [X] Galena [X] Marcasite [ ] Sphalerite [X] Sulfide [X]
Iron Oxide [ ] Limonite [ ] Pyrite [X] Pyrrhotite [X] Stibnite [ ]

Size/Production: Indicate the total amount of ore produced to date in metric tons (mt).

Small (0-10,000 mt) [ ] Small-Medium (10,000mt-250,000mt) [ ] Medium (250,000mt-500,000mt) [ ]
Medium-Large (500,000mt-1,000,000mt) [ ] Large (Over 1,000,000mt) [ ]

Mill Method:

Amalgamation [ ] Arrastre [ ] Gravity [ ] Crusher (only) [ ] Heap Leach [ ] Leach [ ]
CIP (Carbon-in-Pulp) [ ] Cyanidation [ ] Stamp [ ] Flotation [X] * Jig Plant [ ] Retort [ ]
No Mill [ ] Unknown [ ]

Neutralizing Host Rock:

Carbonate [ ] Dolomite [ ] Limestone [ ] Marble [ ] Micrite [ ] Sparite [ ]

Workings/history: Indicate size, number, and type of mine openings, if available.

Intermittent Operations

Years of Operation: From 1912 To 1955

Annual Precipitation: Check one.

Less than 25 centimeters [ ] More than 25 centimeters [X]

5) SPECIALTY DATA: Check all that apply.

Site in a known or suspected floodplain:

None [ ] Annual - 10 years [ ] 10 - 100 years [ ] 100 - 500 years [ ] Less than once every 500 years [ ]

Threatened and Endangered Plants and Animals:

a) Are any threatened and/or endangered plants and/or animals on or near the site? Circle one. YES NO

b) If present, list type(s).

No T&E flora or fauna observed.

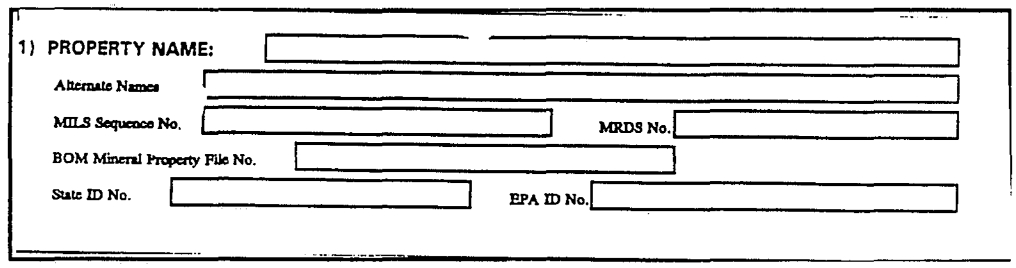
COMMENTS:
* Assumed flotation based on commodities.

Figure 16.--AML data inventory form (pre -field section only)--Continued

Mineral Industry Location System Table

Deposit (property) name (1)--The primary or most commonly used deposit name. The term "deposit" as used here refers to any MAS/MILS entry.

Name (alternate) (1)--Alternate or secondary names associated with this property.


1) PROPERTY NAME:
Alternate Names
MILS Sequence No. MRDS No.
BOM Mineral Property File No.
State ID No. EPA ID No.

Sequence number (1)--A unique 10-digit number used to link various data tables within MAS/MILS and to link a particular MAS/MILS entry to specific mineral property files (see section entitled "Sources of Information--U.S. Bureau of Mines and Mineral Property Files") and to mine map repository files (see "Mine Map Repository" below).

Geological Survey (1)--This field links the MAS/MILS property to an entry in the USGS' Mineral Resource Data System (MRDS). Refer to the discussion of MRDS in the section "Other Sources of Federal Information-- U.S. Geological Survey."

Mineral property file (1)--If this field contains any number, the property has additional information in a file maintained by the responsible Field Center. Refer to the discussion of mineral property files in the section "U.S. Bureau of Mines Sources of Information--Mineral Property Files."

Mine map repository--Some MAS/MILS properties have associated maps of underground mine workings. Such maps would be of value to an AML investigator in evaluating the physical hazards on site. In some cases the maps are proprietary and may not be disclosed without written permission of the property owner. A mine map repository field entry of "A" indicates the map is maintained by the USBM Alaska Field Operations Center; a "W" refers to the Western Field Operations Center; and an "I" indicates the Intermountain Field Operations Center. Addresses and telephone numbers for the three Field Centers are listed in appendix F.

MLA Study area--A "Y" or "Yes" entry in this field indicates the site or general area was studied under the MLA program and an open-file or other report may exist.

Predominant mining method--Describes the method(s) used to extract ore at the mine site. May provide valuable information in the evaluation of potential environmental and/or physical hazards.

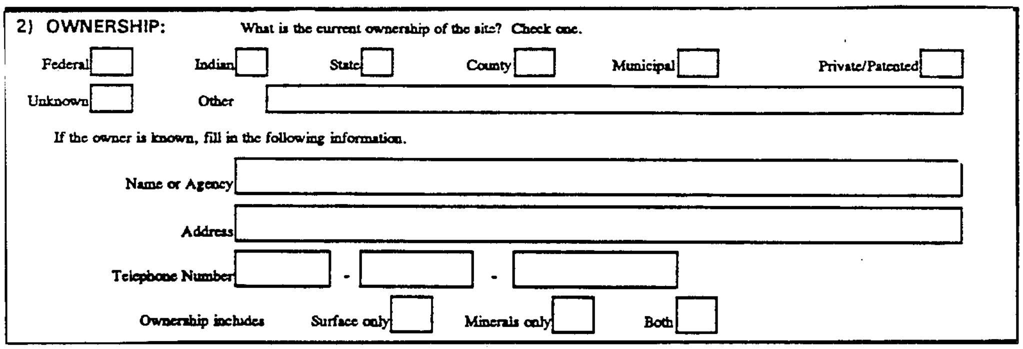
Maintaining Field Center--The USBM Field Center that has responsibility for the maintenance of the particular MAS/MILS property and the Field Center to be contacted for further information.

Mining district--This field contains the name of the mining district in which the property is located. This information may be of use to determine the commodity(ies) or minerals in the area when such data are otherwise unavailable.

Distance to water supply--This datum, while of primary use to USBM engineers, may indicate the presence of surface waters proximal to the site, and may be of value in the evaluation of potential environmental hazards.

Topography--Entries range from "unknown" to "very rugged." This information may provide clues to possible physical hazards (in the cases of rugged--up to 450 m of local relief, and very rugged topography--greater than 450 m of local relief) and may help in logistical planning for site investigations.

Name of owner (2)--When property information other than that provided by MAS/MILS (or other nonproprietary sources of information) is unavailable, it may be necessary to contact the owner to get permission to acquire such proprietary data. By and large, ownership data in MAS/MILS is current as of the date of information (described below). If it is important to ascertain the current owner, the AML investigator is advised to make an inquiry of the county assessor's office in the county in which the property is located. Other sources of current ownership data may be State mining bureaus or State tax offices.


2) OWNERSHIP: What is the current ownership of the site? Check one.

Federal [ ] Indian [ ] State [ ] County [ ] Municipal [ ] Private/Patented [ ]

Unknown [ ] Other [ ]

If the owner is known, fill in the following information.

Name or Agency [ ]

Address [ ]

Telephone Number [ ] - [ ] - [ ]

Ownership includes Surface only [ ] Minerals only [ ] Both [ ]

Year of information--The year in which the ownership information (see above) was current.

Domain (2)--Describes the type of public or private domain of the property.

State (3)--The State in which the property is located.

County (3)-- The county in which the property is located.

Map name and scale (3)-- The name and scale of the largest scale map on which the property is located, typically a 7.5- or 15-min map.

Quadrangle (3)--The quadrangle field identifies the USGS 1:250,000 (1° x 2°) series map on which the property is located.

Latitude (3)--Latitude coordinate expressed in degrees, minutes, and seconds north of the equator.

Longitude (3)--Longitude coordinate expressed in degrees, minutes, and seconds west of the Greenwich meridian.

Elevation (3)-- The elevation in meters of the point of reference. (See "Point of reference" below.)

Principal meridian (3)--The meridian on which the Public Land Survey (PLS) coordinates are based.

3) LOCATION DATA: Fill in location information as available.

State | County
Township | N S | Range | E W | Section
Section Subdivision | Meridian
Latitude | Longitude
UTM Zone | Northing | Easting
Elevation | Specify units for elevation. | Feet | Meters
Map Name | Map Scale
1:250,000 Quadrangle
Mining District
Approximate area of site | Measured in | Square feet | Acres | Hectares

Township (3)–PLS coordinate expressed in 36-square mile increments north or south of the base line associated with the principal meridian.

Range (3)–PLS coordinate expressed in 36-square mile increments east or west of the principal meridian.

Section (3)–PLS coordinate of a 1-square mile portion of the 36-square mile area defined by township and range.

Section subdivision (3)–PLS coordinate expressed as 1/4, 1/16, or 1/64 of a section. Pamphlets, booklets, and other published information that describe the PLS system and how to use it are available at most USGS Map Sales offices.

UTM coordinates (3)–UTM coordinates are generated by computer based on the latitude/longitude entries and are expressed in terms of zone, hemisphere, northing, and easting. UTM coordinates are useful in Geographic Information System (GIS) applications. The reader is referred to U.S. Forest Service Research Note RM-483, "Recording Wildlife Locations with the Universal Transverse Mercator (UTM) Grid System," March 1988, for instructions on how to determine UTM coordinates on a map.

Mining district (3)–Mining district in which the property is located.

Point of reference–This is the physical determination point for the elevation and latitude and longitude. Point of reference may be the main entry of the mine, an exploration trench, the deposit ore body, a claim, pit, or plant (mill).

Precision of point–This gives the precision or maximum deviation from the exact point of reference in meters. Precision is expressed in increments of 10, 100, 250, 500, 1,000, 5,000, 10,000, and greater than 10,000 m. Thus, if a latitude/longitude location is given a point of reference of "Main entrance" and a precision of point of 250 m, then the AML investigator can assume that the mine main entrance would be within 250 m of the point described by the latitude/longitude coordinates.

Elevation precision–This gives the precision or standard deviation for the elevation measurement in meters. Elevation precision is expressed in increments of 10, 100, 500, and greater than 500 m.

Type of operation (4)–The type of mining/milling operation that existed on this site.

Current status (4)–Status of the property as of the date of the last property update. Status entries of the most importance to the AML investigator include "Past producer," "Developed deposit," "Explored

4) HISTORICAL DATA: Check all that apply.

Type of Operation:

Surface ☐ Underground ☐ Surface-Underground ☐ Mineral Location ☐ Placer ☐
Prospect ☐ Dredge ☐ Processing Plant ☐ Well ☐ Unknown ☐ No Data ☐

Status of Operation:

Past Producer ☐ Explored Prospect ☐ Raw Prospect ☐ Unknown ☐
Developed Prospect (greater than 300 meters of workings) ☐

Commodities:

Arsenic ☐ Cadmium ☐ Copper ☐ Lead ☐ Mercury ☐ Zinc ☐
Other (specify) ☐

Commodity Groups:

Metals ☐ Coal ☐ Oil and Gas ☐ Uranium or Geothermal ☐
Industrial Minerals ☐ Sand and Gravel ☐ Non-Energy Leasable ☐
Other (specify) ☐

Acid Producers or Indicator Minerals:

Arsenopyrite ☐ Chalcopyrite ☐ Galena ☐ Marcasite ☐ Sphalerite ☐ Sulfide ☐
Iron Oxide ☐ Limonite ☐ Pyrite ☐ Pyrrhotite ☐ Stibnite ☐

Size/Production: Indicate the total amount of ore produced to date in metric tons (mt).

Small (0-10,000 mt) ☐ Small-Medium (10,000mt-250,000mt) ☐ Medium (250,000mt-500,000mt) ☐
Medium-Large (500,000mt-1,000,000mt) ☐ Large (Over 1,000,000mt) ☐

Mill Method:

Amalgamation ☐ Arrastre ☐ Gravity ☐ Crusher (only) ☐ Heap Leach ☐ Leach ☐
CIP (Carbon-in-Pulp) ☐ Cyanidation ☐ Stamp ☐ Flotation ☐ Jig Plant ☐ Retort ☐
No Mill ☐ Unknown ☐

Neutralizing Host Rock:

Carbonate ☐ Dolomite ☐ Limestone ☐ Marble ☐

Workings/history: Indicate size, number, and type of mine openings, if available.

☐

Years of Operation: From ☐ To ☐

Annual Precipitation: Check one.

Less than 25 centimeters ☐ More than 25 centimeters ☐

prospect," "Raw prospect," and "Unknown." These entries indicate the level of mining activity that occurred at the property.

Commodity Information Table

Commodity (4)--MAS/MILS lists more than 100 commodities that may be associated with a minerals-related operation. In many instances as many as 10 or more commodities were produced by a single operation. Commodities are generally referred to as "primary," the commodity of most importance; "coproduct," of equal importance to the primary commodity; "byproduct," recovered along with the primary commodity; "recoverable," commodity is present but not recovered in the operation; and other commodities that may be detrimental in milling or otherwise affect the marketability of the primary, coproduct, or byproduct.

Modifier--The modifier describes the chemical form in which the various commodities occur. This is very valuable information in that it may provide clues to the bio-availability of metals or other constituents that may pose a potential environmental problem.

Minerals Table

Name (4)--The name(s) of the minerals present on-site are listed in this field. The listing includes ore minerals and minerals associated with the rocks surrounding the ore body ("country rock") and with waste rock ("gangue minerals"). These data are useful in evaluating the potential for environmental problems.

Class--The chemical classification of the minerals named above is listed in this field. Much like the modifier of commodity (discussed above), the chemical classification of the minerals provides insight to the bio-availability of contained metals or other deleterious materials.

Predominant milling method (4)--Describes the method(s) used to mill or beneficiate the ore. Provides clues as to what reagents may have been used at the site.

Lithology Table

Rock name (4)--Lists the rock types associated with the rock formation. Pertinent to potential acid drainage/neutralization.

Formation name (4)--Provides the name of the rock formation in which the deposit or mine occurs. Since most formations are characterized by particular mineral assemblages, knowing the formation name and using it to ascertain the formation mineralogy through the use of a geologic lexicon, may provide clues as to the minerals present (if otherwise unknown). A recommended source of formation names and associated rocks is the Lexicon of Geologic Names of the United States, USGS Bulletin 1200.

Historical Information Table

History of exploration (4)--Exploration data, especially those pertaining to the method(s) employed and the year the method(s) was applied, may provide clues to possible environmental and physical hazards.

Year of discovery (4)--The year the deposit was discovered.

Year of initial production (4)--Year mine commenced operations.

Year of last production (4)--Year mine ceased operations. May provide insight or clues on conditions of workings, equipment, and buildings.

Discovery method--Indicates the methods employed in the discovery of the ore deposit. The data may provide information pertaining to boreholes, exploration pits, trenches, exploration shafts, etc., that may constitute physical hazards.

Predominant mining method--Predominant method used to extract ore. Provides insight as to what types of workings, infrastructure, machinery, etc. might be expected at the site.

Climate and Vegetation Information Table

Annual precipitation and distribution (4)--Provides an estimate (in centimeters) of the area's annual precipitation (rain, snow, hail, etc.) and in what season of the year the most precipitation occurs. The data may be of value in evaluating the environmental hazard potential and in planning site examinations.

Vegetation--Provides information on the type(s) of vegetation found on and around the property.

Climate--Climate entries include "Unknown," "Subtropical," "Tropical," "Temperate," "Cool," and "Cold." Climate and precipitation have a bearing on potential environmental problems such as acid rock drainage.

Ore Body Geometry Information Table

Type of ore body, shape of ore body, and ore controls--These fields are useful in Step II in that they assist in making a decision pertaining to the potential for both environmental and physical hazards and aids in the priority listing of site examinations.

Bibliography Table

The bibliography section contains not only the source(s) of information used in the MAS/MILS entry, but may provide the AML investigator with additional sources of information that may be useful in an AML evaluation.

Figure 15 (p. 35) shows the AML form with line items keyed to MAS/MILS data fields shown on figure 16 (p. 37). The Grizzly Bear Mine, Shoshone County, ID, is used as an example on figure 16. The mine also is used as an example in the discussion of field forms in Step III.

Task 3--Map Data

Before compiling map data, a numbering system should be developed in which each site is assigned a number. This process may be done at the local, area, State, or regional level. The result should be a unique number for each mineral property irrespective of its size. This can be developed using a number for each State, followed by a number for each county within the State followed by a four to six digit site number. This method is used for the deposit (property) "Sequence Number" in MAS/MILS. A standard set of State and county codes is available through the Department of Commerce (DOC). It is strongly recommended that the DOC coding system be used. State and county codes are listed in the following reference:

U.S. Department of Commerce, National Bureau of Standards. States and Outlying Areas of the United States. Federal Information Processing Standards Publ. 5-1, June 15, 1970.

As mentioned above, the DOC system uses a State code followed by a county code. The two codes can be followed by a site-specific code. For example, a designation of 053-063-0001 would represent AML site number 1 in Spokane County, WA. A code of 016-079-0025 would represent the 25th site in Shoshone County, ID. Enter the unique site number on each of the forms.

It is essential to plot the location of each site on the appropriate map. Plotting is best accomplished in two steps. First, obtain a small-scale map as described in Task 1 and plot all of the sites with site reference numbers. Then place a dot on the map for each site or group of sites. Identify these sites by using the "Site No." which was entered on line 1 of the AML forms. This map will be used to develop field plans described in Step III.

Next, perform a careful map-by-map examination, noting the names, locations, elevations (and other map data as required on the pre-field form that may be missing from the MAS/MILS printouts) of all mines, prospects, and any associated mills. Be advised that in most cases minor mines and prospects are not identified on the map(s) by name if, indeed, the property has a name. The locations of the mines or prospects can be determined directly from the map in terms of three locational systems: PLS system coordinates, latitude and longitude, or UTM coordinates. See Greenhood (4) for an in-depth discussion of maps and related materials. Map data should be entered on the pre-field form.

Task 4–Establish a Computer File

If the geographic area of interest is expansive and includes a large number of mines, mills, and prospects, it will be useful to establish a computer file to store and manipulate the collected data. As will be seen in forthcoming sections, the quantity of data required in the pre-field and post-field screening processes could be difficult to handle using only manual methods. A number of commercial software packages for spreadsheets and relational databases such as Lotus 1-2-3, Quattro Pro, dBASE III, among others, are available and are well suited for applications of this nature. Refer to Step II for the names and types of data fields that should be established as part of Task 4. Information from MAS/MILS and the maps, which was entered on the pre-field form, now should be entered in the appropriate computer records.

Task 5–Literature Search

Next, a literature search should be conducted using the information compiled in Tasks 1-4. Literature search, as used here, includes the acquisition of written materials, maps, photographs, remote sensing data, mining district information, and other materials relating to the site, area, or region. The object of the search is to verify as much of the previously acquired data as possible within established time constraints, and to obtain additional or more current information not available through the topographic maps or MAS/MILS. The results will be used as input to the data screening process described in Step II in the next section. In addition to providing screen input, the search may reveal additional sites not identified when compiling the initial inventory. If this occurs, a pre-field form should be initiated for the property and an appropriate computer record established. For the reader's convenience, the types of information an AML investigator should look for in a literature search are summarized below. The summary in part reiterates those critical elements shown on the pre-field form as well as other information that may have a direct or indirect effect on the screening process described in Step II.

1. Property name and any other alternate or former names.
2. Location (PLS, latitude and longitude UTM coordinates).
3. Map names and scales.
4. Type of operation (surface, underground, surface/underground, quarry, open-pit, heap leach, vat leach, placer, or other).
5. Status of property (past producer, developed deposit, explored prospect, unknown).
6. Mineral commodity(ies).
7. Host rock type, particularly if limestone or other predominately calcareous (calcium-bearing) rock type.
8. Ore production (metric tons/year). Production data are not reported in MAS/MILS.
9. When was mine/mill in operation?
10. Type of ore body (fissure vein, disseminated, stockwork, placer, massive sulfide, etc.).
11. Commodity mined (gold, silver, copper, lead, zinc, mercury, etc.).
12. Ore minerals–particularly sulfides.
13. Is pyrite (iron sulfide) present on-site?

On completion of Step I the AML investigator has acquired the data to proceed to Step II in which they will be screened to produce a ranked listing of AML sites within the area of interest.

CHAPTER 6

STEP II--SELECTING SITES FOR FIELD INVESTIGATION

It is not economically feasible nor is it practical to examine all sites identified during the AML identification process. The purpose of Step II is to provide a methodology to systematically rank sites with respect to their hazard potential. The product of this exercise identifies those sites that should be given first consideration for further investigation, including possible field examination. These sites are identified by numeric hazard values assigned to them. The values are based on hazard factors which are assigned to selected fields of a computer spreadsheet or database. The hazard factors are determined from data in MAS/MILS or other sources of information. Table 2 lists all fields that will be required. Discussions later in the Task portions of this section will provide instructions for data input to the new fields.

Table 2.–Suggested field names and spreadsheet structure (types and lengths) for fields used in site hazard rating and priority listing

General name	Field acronym	Field type	Field length
SEQUENCE NUMBER	SEQ	C	10
COMMODITY1	COMMO1	C	10
COMMODITY2-6	COMMO2-6	C	10
STATUS	CUR	C	12
PROPERTY TYPE	TYP	C	12
ORE PRODUCTION	PROD	C	36
HOST ROCK	HOST	C	10
ORE MINERALS	OREMIN	C	42
NON-ORE MINERALS	GANGUE	C	42
SIZE PRODUCTION	SIZE	C	12
MILL TYPE	MILLTYPE	C	12
ANNUAL PRECIPITATION (in cm)	PPTN	C	3
ACID POTENTIAL	ACIDPOTL	L	1
HUMAN HAZARD VALUE	HHAZVAL	N	5
ENVIRONMENTAL HAZARD VALUE	EHAZVAL	N	5
HAZARD RATING OVERALL	HAZRATE	N	5
PHYSICAL HAZARD VALUE	PHAZVAL	N	5

C Character.
L Logical.
N Numeric.

Note.–Do not confuse values calculated or determined for the "Overall Hazard Rating" in the following tasks with the EPA Hazard Ranking System of Superfund (CERCLA) hazardous waste sites. The priority listing/ranking system in this methodology uses numbers representing "hazard factors" that are empirical in nature. The factors are based on arbitrarily selected values reflecting the professional opinions of how mine/mill characteristics may relate to potential hazards. These values represent the "perceived relative hazard potential" of a specific site characteristic. In essence, this procedure is a common sense approach that uses a numerical system for comparing mineral sites.

For example, the potential for hazards at a large mine would be greater than at a smaller mine. A mine with an on-site mill would have a greater hazard potential than one without a mill. A mill that used cyanide or mercury amalgamation for commodity recovery would have a higher hazard potential than a simple heavy-media separation process. The end number or "Overall Hazard Rating" represents a ranking for potential hazards to aid the investigator in the selection of sites for actual field investigation.

As previously discussed, there are two hazard types: Environmental (or chemical) and physical. This methodology is designed to identify and rank the chemical hazard potential of past mine activities only. This methodology subdivides chemical hazards into two categories, human and ecology (environment). Chemical conditions often pose a different hazard risk to humans than to flora and fauna. The difference in risk hazards between human and ecology stems from the chemical risks and properties intrinsic to differing elements/commodities. For example, the commodity asbestos poses a carcinogenic risk to humans but poses a lesser risk or concern to the ecology. Table E-1, appendix E, lists commodities with their respective human and ecology risk factors.

A computer "spreadsheet" software program such as Lotus 1-2-3 or Quattro/Quattro Pro is recommended for hazard value calculation. It is assumed that the reader either has knowledge or personnel resources available with a fundamental knowledge of spreadsheet software operations. Unless the number of mineral sites of concern is relatively small, manual calculation and ranking of sites by hazard value is time consuming. Although the mathematics entails simple multiplication of hazard factors, it is often necessary to make several iterations of the calculations as data fields are updated with new or additional information. The computer serves this process well.

The process of calculating potential hazard values and priority listing/ranking mineral sites begins when literature and information searches have been completed, Part 1 of the AML Inventory Form has been completed, and, if desired, mineral site data entry into a computer file has been completed.

TASK 1--SPREADSHEET FIELD SELECTION AND COMPLETION OF EXISTING FIELDS

A spreadsheet template may be obtained from the Bureau's Western Field Operations Center, 360 E. Third Avenue, Spokane, WA 99202, telephone (509) 353-2700, facsimile (509) 353-2661.

Ensure that the following spreadsheet fields are defined and the data have been entered manually or extracted from a computer data file and imported into the spreadsheet. The data should be verified to the maximum extent practical:

- Site number (SEQ)
- Property name (NAM)
- Commodities, up to 6 (COMMO1, COMMO2, . . . COMMO6)
- Status (CUR)
- Property type (TYPE)
- Ore production (PROD)

- Mill method (**MILLTYPE**)
- Ore minerals (**OREMIN**)
- Non-ore minerals (**GANGUE**)
- Host rock (**HOST**)
- Precipitation (**PPTN**)

The four most important fields of information for mineral sites in the "site-ranking process" are commodity, status, size, and mill type. A thorough literature search should provide adequate data for significant past producing mines. In those rare instances where one does not have data for one or more of these key fields, one should enter a code such as "**ERR**" in the field. This code will serve as a flag for additional scrutiny. In actual practice, many properties lacking data for these fields will be small and insignificant. In other words, they have never warranted a writeup with regard to their historical and geological significance. In most instances it may be appropriate to assume these properties have default values such as **STATUS** equal to "raw prospect," or "explored prospect;" **SIZE** equal to "small;" and **MILLTYPE** equal to "none." For **COMMO1**, assign the single most significant commodity for the mining district within which it lies or to which it is adjacent.

TASK 2--DETERMINATION OF "SIZE" AND "ACID POTENTIAL"

SIZE (**SIZE**)--Enter the appropriate "size" code that best describes the property. The value for the **SIZE** field is developed from data contained in the "Ore Production" (**PROD**) field. Use table E-4, appendix E for the code that best describes the known or estimated ore production provided or described in the **PROD** field. For example, mines having past ore production of 7,700 mt and 123,000 mt would be classified and coded as "small" and "small-medium" in size, respectively.

Acid Potential (**ACIDPOTL**)--The presence of acid drainage from a mineral site poses a risk that is largely dependent on the availability of water or precipitation, presence of pyrite ("fool's gold"), and the absence of a neutralizing host/country rock. Pyrite is the principal mineral of a suite of minerals that provide sulfur in sulfuric acid drainage. Other acid-forming minerals include arsenopyrite and pyrrhotite. Pyrite is a very common mineral in sulfide mineral deposits. It is often not reported in the literature description of a mineral site, nor is its presence always easily observed, especially at a well-oxidized site. Table E-7, appendix E, provides a more complete list of ore and gangue minerals that either contribute to, or are indicators of, other potentially present acid formation minerals.

The yes (Y) or no (N) entry for field "Acid Potential" (**ACIDPOTL**) is determined by using the combined fields Ore Minerals (**OREMIN**), Non-Ore Minerals (**GANGUE**), Host Rock (**HOST**), and Annual Precipitation (**PPTN**). . . . .

The following procedure is used to provide the "Y" or "N" entry into the field "Acid Potential" (**ACIDPOTL**):

- If fields **OREMIN** or **GANGUE** contain any minerals listed in the lookup minerals list provided in table E-7, appendix E, and

- the host or country rock name listed in the database field **HOST** does not appear in the lookup list provided in table E-8, appendix E, and

- the local annual precipitation in the field **PPTN** is greater than 25 cm, enter "Y" for the potential for acid drainage.

- If not "Y", then enter "N" for no or little acid mine drainage risk. For example, using fields **OREMIN, GANGUE, HOST, PPTN**, and tables E-7 and E-8, appendix E, the "acid potential" (**ACIDPOTL**) for a deposit having a lead-zinc vein with limonite gangue in a granodiorite host where precipitation was greater than 25 cm/yr would be "Y" (yes). The same situation above with either a limestone host or low annual precipitation (less than 25 cm/yr), or no ore/gangue minerals listed in table E-7, appendix E, would have the value of "N" (no) in the **ACIDPOTL** field.

TASK 3--CALCULATION OF CHEMICAL HAZARD VALUES: HUMAN, ENVIRONMENTAL, AND OVERALL

This task uses numerical hazard factors assigned to field codes listed in tables E-1 through E-6 in appendix E to calculate hazard values. Calculated values using these factors will be entered into additional fields of the spreadsheet. The final "Hazard Rating Overall" is equal to the higher of the two calculated value entries for **HHAZVAL** and **EHAZVAL**.

(1) To calculate the "Human Hazard Value" (**HHAZVAL**) for each mineral site, first use fields **COMMO1** through **COMMO6** and select the highest "Human" factor for those commodities. Multiply this "human commodity factor" by all other hazard factors for the mineral site found in tables E-2 through E-6 of appendix E. The calculated value is entered and stored in the field **HHAZVAL**. Simply stated, the calculation is: (Highest Human Commodity Hazard Factor) x (Status Hazard Factor) x (Property Type Hazard Factor) x (Production Size Hazard Factor) x (Mill Type Hazard Factor) x (Acid Potential Hazard Factor) = **HHAZVAL**.

(2) Calculate Environment Hazard Value (**EHAZVAL**) in a similar manner. The highest "Environmental" hazard factor is chosen from table E-1, appendix E for the commodities occurring at each mineral site and is in turn multiplied by hazard factors for the field values describing each mineral site in tables E-2 through E-6, appendix E. The result is entered and stored in field **EHAZVAL**.

(3) The higher of the two values of fields **HHAZVAL** and **EHAZVAL** is entered in the field **HAZRATE** as the overall hazard potential of the mineral site.

TASK 4--RANKING AND PRIORITY LISTING

The process of "ranking," as defined in this methodology, is the ordering or relative positioning of values with respect to other values in the same group. This process is simple and fast when done using the sorting features of a spreadsheet. Basically, one selects a field such as **HHAZVAL**, **EHAZVAL**, or **HAZRATE**, sorts the data, and lists mineral sites numerically from the highest hazard potential to the lowest.

A priority listing is the task wherein managers/investigators must decide what to do with the ranked sites. The primary decision to be made is whether to conduct site examinations, and, if so, which sites? Prioritization is in part a subjective action because it involves decisions based on agency goals, time, budgets, remoteness, data integrity, risk levels, etc., and not scientifically established rank/action criteria.

For example, the decision may be to examine "the potentially worst 10 pct" or "those that rank above a certain natural break in the rankings" or "sites within 30 km of a population center" or " those that can be examined by 1 person in 2 months."

Examples

Example 1:

A. The Blue Bell Mine (fictitious) is a replacement deposit in limestone country rock. It produced 36,000 mt ore from 1932 to 1946. The deposit is accessed by two adits and has more than 1,100 m of underground workings. Ore minerals include chalcopyrite and sphalerite. Associated gangue minerals are pyrite, arsenopyrite, calcite, and siderite. Copper and zinc concentrates were produced in an on-site mill using flotation methods. The area has an annual precipitation rate greater than 60 cm/yr.

B. Calculation of human and environmental hazard values

1. Field entries and codes will be:

Commodity	= "arsenic" with human hazard factor	= 7
	"copper" with environmental hazard factor	= 5
Status	= past producer--hazard factor	= 2
Property type	= underground--hazard factor	= 1.2
Size	= small-medium--hazard factor	= 1.4
Mill method	= flotation--hazard factor	= 2.2
Acid potential	= n--hazard factor	= 1

2. Calculations: (involves multiplication of field code hazard factors)
<u>Equation hazard values:</u> Commodity x Status x Type x Size x Mill Method x Acid Potential
<u>Human hazard values (HHAZVAL):</u> (7)x(2)x(1.2)x(1.4)x(2.2)x(1) = <u>51.7</u>
<u>Environmental hazard value (EHAZVAL)</u> = (5)x(2)x(1.2)x(1.4)x(2.2)x(1) = <u>37.0</u>
<u>Overall hazard rating (HAZRATE):</u> = <u>51.7</u>

C. Comments: The commodity arsenic is from the gangue mineral arsenopyrite. The human hazard factor for arsenic was used as a human hazard as it had a higher value than either copper or zinc. One should also consider the possibility of the presence of the commodity "cadmium," a common byproduct of sphalerite. Acid production is not a concern (hazard value of 1) as the host rock is limestone, a neutralizing agent. Overall hazard rating is equal to the higher value of the two values calculated for human and environmental.

Example 2:

A. The Pioneer Mercury Mine (fictitious) produced 3 flasks of mercury in the early 1920's from an estimated 10 mt of ore. The property consists of two small pits in a volcanic host. Ore minerals include cinnabar and free mercury. The area is dry desert, and precipitation is less than 25 cm/yr. No mill is present.

B. Calculation of human and environmental values

1. Field entries and codes will be:

Commodity	= "mercury" with human hazard factor	= 9
	"mercury" with environmental hazard factor	= 6
Status	= past producer--hazard factor	= 2
Property type	= surface--hazard factor	= 1.2
Size	= small--hazard factor	= 1.2
Mill method	= no mill--hazard factor	= 1
Acid potential	= no--hazard factor	= 1

2. Calculations:

Human hazard value (**HHAZVAL**) = (9)x(2)x(1.2)x(1.2)x(1)x(1) = 25.9

Environmental hazard value (**EHAZVAL**) = (6)x(2)x(1.2)x(1.2)x(1)x(1) = 17.3

Overall hazard rating (**HAZRATE**) = 25.9

C. Comments: Based on data obtained from pre-field literature search and contained in the narratives, values for the hazard potentials calculated for Example 1 are higher than Example 2. If these examples were two among many other mineral sites studied and potential hazards calculated, one would compare these site hazard values with others. Comparison is more easily done by ordering/ranking sites by the **HAZRATE** value from high to low. The sites with the highest overall hazard ratings could be the first ones scheduled for on-site investigation.

CHAPTER 7

STEP III--CONDUCTING A SITE INVESTIGATION

Step III in the AML inventory/investigation process is to prepare for the site examination and then prepare a record of the apparent potential environmental, public safety, and reclamation hazards on-site. The ultimate purpose of this work is to gather information necessary to identify sites that require future action and to gain an insight of the magnitude of environmental or physical hazards, or reclamation problems, if they are present. Documentation developed at a given site may represent the only information available on the site, and represent the sole basis for a decision as to whether additional expensive, detailed work is necessary; thus, accuracy is imperative.

To accomplish this step, both environmental and physical potential hazard information is recorded. The process is divided into two groups of tasks: (1) preparation for the site investigation; and (2) conducting the site investigation. Work in both groups is based on the assumption that results from Step I and Step II have been assembled into a usable format. The tasks for Step III are summarized below by each group and are discussed in detail in later sections.

<u>Group 1</u> - **Preparing for Site Investigation**

Task 1. Determine access routes.
Task 2. Obtain necessary training.
Task 3. Obtain necessary equipment.
Task 4. Prepare travel itinerary.

<u>Group 2</u> - **On-Site Investigation**

Task 1. Travel.
Task 2. Start site examination process.
Task 3. Review the AML Inventory Form.
Task 4. Complete the field form.
Task 5. Review form and all data sets for completeness.

<u>GROUP 1--PREPARING FOR SITE INVESTIGATION</u>

Task 1--Determine Access Routes

Access can be one of the most critical parts of planning. Use the small-scale maps prepared previously to develop general access and logistics plans for a given area of work. Large-scale maps mentioned previously are used to determine the access to specific sites or groups of sites. During this process, note carefully the type of roads available and their description in the map explanation. Dashed roads or "Jeep Roads" are often rough to rugged and may require a 4-wheel drive vehicle and a driver with 4-wheel drive experience (see appendix G for suggested training). Note areas of special significance such as creek and river crossings, rocky slopes, abrupt changes in slope, swampy areas, and sudden changes in vegetation (vegetation is often noted on the map in green; white generally denotes a lack of vegetation). These areas could represent danger spots. While driving to and from these areas also watch for ruts, gullies, side-hill road cuts, and other unusual conditions. <u>USBM experience indicates that more</u>

accidents occur in transit to and from old mine sites than at the sites themselves, therefore, access planning and caution are critical.

Task 2--Obtain Necessary Training

Proper training is critical in traveling to and from the sites as well as working at the sites. Appendix G lists suggested training courses available from a variety of sources. Specific individual training should be based on organization or agency requirements, individual need, and availability. Training may include vehicle operation, first aid, equipment operation, and hazardous materials.

Task 3--Obtain Necessary Equipment

Another essential aspect of evaluation is appropriate equipment. Appendix H lists various recommended equipment for both vehicles and site evaluation. The AML Inventory Pre-field and Field Forms are both critical parts of this equipment, as is a "Polaroid" or other type camera and film. Prepare the vehicle, vehicle equipment, and personal equipment for fieldwork. Material from Tasks 1 and 2 of Step I also should be included.

Task 4--Prepare Travel Itinerary

A travel itinerary and plan must be developed. This should include lodging locations, location of nearest emergency facilities, emergency telephones, and other agency-specific procedures. Safety is critical in all phases of this work. It is strongly recommended that people work in pairs when in areas of past mining activity.

GROUP 2--ON-SITE INVESTIGATION

General Field Investigation Philosophy

The goal of an on-site field investigation is to answer two questions: (1) does a problem exist, and (2) if so, how severe is the problem. A problem may be simple or complex in nature. Also, problem severity can be divided into "actual" and "relative" severity. For example, a 50-ft-deep shaft has a certain amount of danger irrespective of location (actual severity). However, it is more dangerous (relative severity) to humans if located near a popular hiking trail.

Effective field investigation is based on a good strategy developed well before entering the field. Upon arrival at a site, concentrate on the major or gross features, not the details. The details will be examined later if the site warrants further work. In general, look for indicators of both environmental problems and physical hazards.

To meet the stated goal, data must be collected on what is present, its condition, size, shape/depth, presence of certain metals, stability, and actual dangers. These data are collected through a series of questions presented in two groups on a field data form: site data and feature data. Site-wide potential problems vary considerably in severity, as do feature-specific problems. Thus the focus of the form from general to specific is to help the user focus on significant data. Each part of the field form leads one step-by-step through the data acquisition process and explains what specific items to look for or examine. Appendix I summarizes the feature groups, individual features, observations needed, and the meaning of each observation.

A brief field examination offers only limited choices of what to do if a problem is discovered. For most environmental physical hazards (e.g., an old barrel of chemicals), the only response is to note the problem on the form and follow agency-specific procedures for handling this type of situation. In a few cases the problem will be so severe that immediate response is necessary (e.g., a leaky drum of chemicals). In such cases, note the problem in the comments section at the bottom of the field form and handle according to agency policy. But, in general, subsequent detailed examinations will define the problems and aid in developing proposed solutions.

Field Form

Mining, milling, and smelting are early phases of minerals acquisition and use (fig. 17) and operations range from small prospects to major facilities. This broad range gives an equally broad range of both physical and environmental problems. A standardized methodology is necessary to consistently determine the existence and severity of either category of problem at a given site. This is best accomplished with a standardized form. The form must be easy to use, gather all essential data, and be flexible enough to work with at any site examined. The example form presented in appendix C accomplishes these goals. The underlying strategy for site investigation is to minimize field data collection costs and maximize relevant data collection.

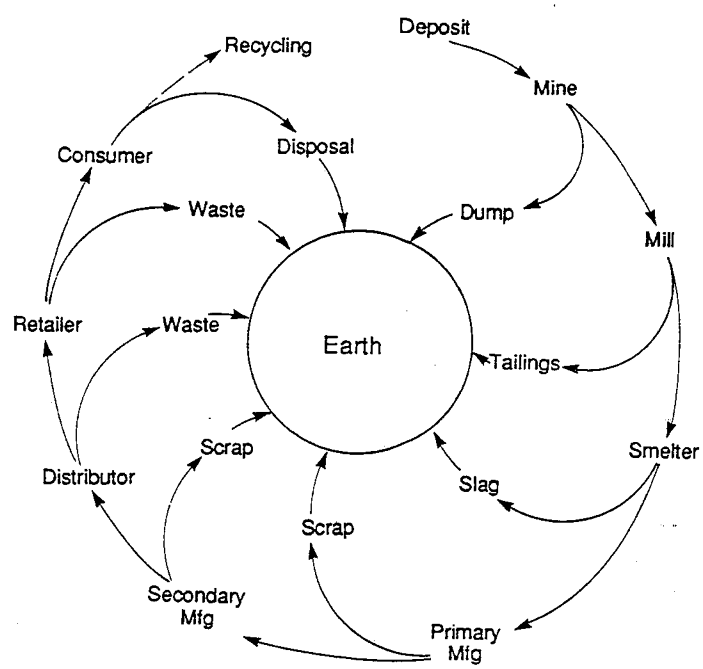


Figure 17.–Minerals life cycle of discovery, processing, use, and disposal.

The amount of time available to visit a given site is assumed to be very limited, generally one-half day, assuming one-half day for preparation and travel. That assumption is reflected in this field form. Notably:

- No sampling for chemical analysis of rock, soil, or water is required; indirect indicators will be used to determine if environmental problems exist, and
- Actual measurements will be restricted to pH, conductivity, radiation, and estimated dimensions.

As discussed earlier, the form has two major sections, <u>pre-field and field</u>. The field section, described here, is designed for both site and feature-by-feature evaluation and uses a single page form to inventory each significant mine- and mill-related feature. The form allows for the use of sketch maps and photos which results in a quick and easy field inventory system, and allows for future automated data and record storage and processing.

Site safety is a critical factor. <u>NEVER GO INTO AN UNDERGROUND MINE WITHOUT PROPER EQUIPMENT AND TRAINING.</u> It is also wise to stay out of buildings that appear unstable or are partly collapsed. The form is designed assuming that a person will <u>NOT</u> go into these areas.

Task 1–Travel to the General Area/Conduct Reconnaissance

For Task I, the AML investigator travels to the general area where the site or group of sites is to be examined. A reconnaissance (a rapid perusal of the general area in which the sites are located) is advisable to determine if any additional sites are present that were not discovered in the pre-field studies of Step I. When conducting a reconnaissance review of an area, several items are of particular use to help determine (or verify) one's location. These include both large- and small-scale maps, a compass, and a Global Positioning System (GPS) receiver.

If additional sites are discovered, note their presence, location, and gross features. Complete the pre-field portion of a form for each site or group, apply the screen (as described in Step II), and add these new sites to the previously developed list of sites. Assign each new site a unique site number. It may not be possible to complete all of the pre-field section of the form at this time. Critical data fields include line numbers 1, 2 (if possible), and 9 through 16. Fill in any other data that are available. If all of the critical items cannot be filled in, fill in as many as possible and proceed to the next section.

Task 2–Start Site Examination Process

Start the site examination process by going to the most important site first. Then, proceed through the following:

(1) Ensure you are at the proper location.
(2) Verify that the location plotted in Step I is correct.
(3) At a viewpoint, spend some time viewing the general features of the area and site prior to site entry.
(4) To the right is a features group list. Use this list to begin organization of the site investigation. Items are listed in the general order in which minerals pass through the mine/mill system.
(5) Conduct a general reconnaissance of the entire site. Carefully walk through and around the area to determine the size and nature of the site. See appendix I for details of site features, concerns, and actions.
(6) Prepare a sketch map of the general relative locations of the major features or feature groups.

<u>Typical Groups of Features</u>

1. Mine Openings Features
2. Mine Infrastructure
3. Mine Dumps
4. Mine Ore Stockpiles
5. Raised Structures
6. Mill Infrastructure
7. Mill Tailings
8. Leach Pads and Solution Ponds
9. Suspended Systems

Task 3--Review the AML Inventory Form Parts I and II

Review the AML Inventory Form, Part I-Pre-Field Data, for completeness. If possible, fill in any blanks.

General site data should be collected and all significant features at a mine, mill, or related site must be documented. Review the Part II-Field Data form to devise a plan to collect both general site data and data on each feature identified. USBM experience indicates one of the best ways to collect site data is to work step-wise through the features groups. This assures completeness and reduces confusion.

Task 4--Complete the Field Form

The AML Inventory Form, Part II-Field Data, is discussed in detail below. Part III-Supplementary Data, provides a gridded format for recording sketches and notes and for attaching photographs.

For example purposes, the Grizzly Bear Mine (fictitious) used in the discussion of MAS/MILS data in Step I will be used here. It has one open and one caved adit, a mine dump, the remains of a mill, and some mill tailings. The Grizzly Bear Mine does not contain any ore stockpiles, raised structures, leach pads, solution ponds, or suspended systems.

Form Heading

Each form has a title, header information, and questions. Field questions are divided into two sections, site related and feature related.

Five groups of information occur at the top of Side 1 of the field form: Date of Investigation, Page Number, Global Positioning System (GPS) Location, Site Number, and Site Name. All but the GPS location are repeated at the top of Side 2. For Site No., fill in the site number identifier generated in Step I, Task 3 in the blank box. Example 1 shows the completed section. Note that the form is labeled "Part II-Field Data (Side I) Site Data" (see Example 1).

A second group of questions at the top of Part II-Field Data (Side I) records agency specific information. Questions include: Evaluator, Agency, Address, and Telephone No. An example of completed questions is shown below.

INVESTIGATION DATE 4-28-93 PAGE 1 OF 3
GPS LOCATION N-5279969 E-556613
SITE NUMBER 0160799203 SITE NAME Grizzly Bear

EVALUATOR John DOE AGENCY USBM
ADDRESS E.360 3rd Ave, Spokane, WA TELEPHONE (509)353-2700

Example 1.--Page heading information with completed items.

Form Sections

The first section of the form addresses site-related questions; the second section addresses feature-related questions. Complete one form for the site and one copy of Side 2 for each feature identified in question 10 at each site (see question 10 discussion). For example, if a site has two adits, two dumps, and a mine supply shed, complete one copy of Side 1 and five copies of Side 2. All five Side 2 pages would have the same site number, probably the same evaluator, and the same date, but different page numbers. For questions 1 through 9, answer each which pertains to the site under examination. If a question is not relevant, continue to the next question. For questions 10 through 18 answer each that pertains to the feature under examination. If a question is not relevant, continue to the next question.

A detailed explanation of questions 1 through 18 follows.

Site Related Characteristics

Question 1

The first question (see Example 2) is **NEAREST SITE(S) OF HUMAN ACTIVITY.** Give the distance and circle units or mark N/A (not applicable) for each item: dwelling, school, work place, campground, trail, or road. This information will be used to evaluate the relative danger of a given condition.

1) NEAREST SITE(S) OF HUMAN ACTIVITY (Give distance, circle units, or mark N/A)

Dwelling(s)	5	km	mi
School	N/A	km	mi
Workplace	N/A	km	mi
Campground	N/A	km	mi
Trail	N/A	km	mi
Road	N/A	km	mi

2) SENSITIVE ENVIRONMENTS (If any, give name or distance, if known) Circle one per group

	(If any, give name or distance, if known)				
a) Threatened and Endangered Species			UNK	YES	NO
b) Wetlands		km mi	UNK	YES	NO
c) Fisheries		km mi	UNK	YES	NO
d) Other		km mi	UNK	YES	NO

Example 2.--Nearest sites of HUMAN ACTIVITY and SENSITIVE ENVIRONMENTS questions from field form, with example answers.

Question 2

Question 2 (see Example 2) is **SENSITIVE ENVIRONMENTS.** Circle one, **Unk** (unknown) **Yes** or **No.** If the answer is yes, as appropriate, give the name of the "Threatened and Endangered" (T&E) species or the distance from the site to the wetlands, fisheries, or other sensitive environment. Circle proper units. A sensitive environment is one that may be adversely affected by the presence of heavy metals. The choices are: (a) T&E species; (b) Wetlands; (c) Fisheries; and (d) Other. For T&E species, local land managing agency offices are often a good source of information.

"Sensitive environments" consist of three highly complex issues: wetlands, fisheries, and threatened and endangered species. Information regarding sensitive environments can often be obtained by contacting the local Forest Service Ranger District, BLM, or U.S. Fish and Wildlife Service offices with regulatory responsibility for the larger ecoregion or specific mine area.

Question 3

Question 3 (see Example 3) is **WATER**. Presence of water is a significant item to note. "Are bodies of water (i.e., rivers, lakes, etc.) found on or within 2 miles of the site?" Circle **Yes** or **No** and check all that apply; five choices are given, or, fill in the space labeled "Other."

In our example the Grizzly Bear Mine is near (less than 2 miles) Gold Creek; circle **Yes**, place an "X" in the box by "Stream," give the creek name and note the distance of 0.1 mile.

Question 4

Question 4 (see Example 3) is **AIRBORNE POLLUTANTS**. Circle **Unk, Yes**, or **No** and mark all that apply. The choices include: Dust (as in blowing dust from a mill tailings pond), Spray (e.g., a leaky pipe), Vapor (e.g., an open barrel of chemicals), or Other (to be filled in as appropriate). Dust could carry heavy metals, if present, and contaminate surrounding areas. Spray or vapor could be hazardous locally.

In our example a small amount of dust from the mine dump is noted on a very windy day; circle **Yes** for dust as a precaution. There are no other visible airborne pollutants; all other answers are circled **No.**

3) WATER Are bodies of water found on or within 2 mi (3.2 km) of the site? Circle one, and check all that apply. YES NO

Stream [X] River [ ] Pond [ ] Lake [ ] Bay [ ] Other [ ]

Name of nearest water body [Gold Creek] Distance [0.1] km mi

4) AIRBORNE POLLUTANTS

		Circle one per group	
a) Dust	UNK	YES	NO
b) Spray	UNK	YES	NO
c) Vapor	UNK	YES	NO
d) Other Name [ ]	UNK	YES	NO

Example 3.–Example of completed question 3, WATER, and question 4, AIRBORNE POLLUTANTS.

Question 5

Question 5 (see Example 4) deals with uranium and related radioactive minerals: **RADIATION.** Specifically, "Did pre-field research indicate this area has produced uranium?" Circle **Yes** or **No.** If pre-field data indicate that an area has uranium or has had uranium production, then line 19 on the pre-field form should be answered yes, and likewise this question is answered yes. So to answer this question, simply refer to line 19 on the pre-field form.

If the answer is yes, use a radiation meter to measure the amount of radiation (usually in counts per second [cps]) present at the site. Stand approximately 7 m (23 ft) away from the area in question to collect the reading. If collecting a reading from a mine dump or mill tailing, stand in the center of the exposed surface to collect a reading and so note on the form. Once collected, record the value in the box

5) RADIATION Did pre-field research indicate this area has produced uranium? Circle one. YES NO

If yes, take radiation reading and record value. [80] Counts per second (cps)

6) EXPLOSIVES Are any explosives or blasting supplies found on the site? Circle one. UNK YES NO

If present, list type and location. [Dynamite in adit near portal]

7) OTHER Are any of the following present? Check all that apply, provide comments as necessary below.

Acrid Odor [ ]	Drum(s)/Tank(s) [ ]	Overhead Wire(s) [ ]	Power Substation(s) [ ]	Tramway(s) [ ]
Antennas [ ]	Fence(s) [ ]	Pipe(s) [ ]	Scrap Metal [ ]	Transformer(s) [ ]
Aviation Hazard(s) [ ]	Flume(s) [ ]	Pole(s) [ ]	Tower(s) [ ]	Trestle(s) [ ]
Bag(s) [ ]	Headframe(s) [ ]	Power Line(s) [ ]	Tram Bucket(s) [ ]	Wooden Structure(s) [ ]
Chemical(s) [ ]	Overhead Cable(s) [ ]	Other (specify) [NONE]		

Site appears to have cultural significance or value [ ] (Check if yes)

Example 4.—Example of completed questions 5, RADIATION; 6, EXPLOSIVES; and 7, OTHER.

labeled "Counts per second (cps)."

In the Grizzly Bear Mine example, it is not certain that the mine produced uranium. It is known, however, that the mine produced lead and zinc; but, an obscure comment was found during the pre-field work about a uranium prospect somewhere in the general area. It would be prudent to take a reading just to be sure. At a distance of 7 m (23 ft) from the adit entrance, a reading of 80 cps is received. Enter the data in the appropriate box to the right (see Example 4), and go to the next question.

Question 6

Question 6 (see Example 4) is **EXPLOSIVES**. Specifically, "Are any explosives or blasting supplies found on the site?" Answer by circling **Yes**, **No**, or **UNK** (unknown). If present, list the type and location in the box provided. For this question, the explosives or blasting supplies do not have to be at the feature listed, but can be nearby. Be sure to note the location of such material.

IF ANY EXPLOSIVES, BLASTING CAPS, OR SUPPLIES ARE PRESENT, DO NOT TOUCH!!!!

In the Grizzly Bear example, a box of dynamite was seen near the entrance perched on a dry part of the floor (fig. 9). Note this on the sketch map and on the form. The beads on the dynamite (fig. 10) are nitroglycerine, which is **VERY DANGEROUS AND MUST NOT BE TOUCHED**. As shown in example 4, **Yes** is circled and "Dynamite in adit near portal" is written in the blank box.

Question 7

Question 7 (see Example 4) is **OTHER** and applies to the entire site. Specifically, "Are any of the following present?" Place an "X" or check in the box beside all that apply, and provide comments as necessary in the comments section. The choices include: Acrid odor, drums, headframes, antennas, tramways, bags, scrap metal, wooden structures, overhead cables, overhead wires, pipe, flumes, trestles, power lines, tram buckets, poles, towers, power substations, transformers, and fences. If there are items present that are not listed, fill in the box "Other." Also note, by marking the "yes" box, if the site appears to have cultural significance or value.

Several of the above items deserve supplemental definition: headframes are structures above a shaft to hold machinery used to lift ore; bags refers to large paper or fabric bags used to hold chemicals; poles refers to large cylindrical wood or metal objects used to support electrical wires, cables, or other devices.

If drums and bags are present, look for labels, but DO NOT handle or get too close. If labels are present and readable from a distance, note label information in the comments section.

In the Grizzly Bear Mine example, none of these items were noticed so the word "none" was placed in the box labeled "Other."

Question 8

Question 8 (see Example 5) is **PHOTOGRAPH NUMBERS**. This is a blank box to record all photo numbers for photos collected of this specific feature.

In the Grizzly Bear Mine example, one photograph was taken at the open portal feature. The photograph was labeled and assigned the number 0160799203-1. This number was written in the blank box of question 8.

8) PHOTOGRAPH NUMBERS Ø16 Ø7992Ø3-1

9) SKETCH NUMBERS 1, 2

COMMENTS

Mine water flows into nearby creek.

Example 5.—Sample of completed question 8, PHOTOGRAPH NUMBERS; question 9, SKETCH NUMBERS; and COMMENTS.

Question 9

Question 9 (see Example 5) is **SKETCH NUMBERS**. In this box, record the numbers of each sketch map made of this particular feature and the sketch map which contains the location of this feature.

In the Grizzly Bear Mine example, a general reconnaissance sketch map was prepared and this adit feature was located on the reconnaissance map.

Comments

This box is provided to allow for discussion of anything not covered specifically in the form. Comments could include: road accessibility of site, general geology, minerals present, and other special features.

If the site has one or more large mine dump or mill tailings piles, or large or deep workings, note any heavy equipment access problems (for possible site characterization or remediation) .

Pay particular attention to the type and character of buildings, equipment, and other features that are of a cultural nature. Note and photograph both the presence, location and condition of these features.

In the Grizzly Bear Mine example, water was flowing from the adit. This water was traced to a location where it entered a nearby creek. The following note was entered in the comments section, "Mine water flows into nearby creek."

Photography

A photograph is recommended to record a specific feature or condition. Use a "Polaroid" type camera for this purpose as it produces 'instant' pictures which can be numbered and labeled. A second camera of some other type also may be of use. Stand far enough away from the feature to photograph any pertinent aspect, including country rock and stains. In some instances, closeup pictures may be best. Each photo should have a photo number (described below).

Photo Numbering System

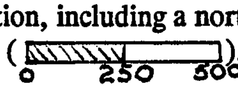
The photo numbering system used here is designed as a two-part system, specifically: first is the site number and second is the feature number; the two are separated by a dash. If more details are necessary, a letter prefix may be added to the feature number. For example, "A" for adit, "S" for shaft, etc.

Always place the site number and feature number, where appropriate, on each photo taken. This prevents confusion of photos among sites, should they become mixed.

BE SURE PHOTO NUMBERS ALWAYS ARE RECORDED ON AT LEAST ONE SKETCH MAP. WITHOUT THIS RECORDATION, THE EXACT LOCATION OF THE PHOTO IS UNCERTAIN.

Sketch Map

Once the photos have been collected and numbers assigned, add the numbers to the initial sketch map prepared during the reconnaissance review. If items are too small on this map to allow for adequate detail, supplemental larger scale (covers a small area) sketch maps may be necessary and can be prepared for any part of the site. Place a rectangle on the initial map showing the areas where larger scale maps are situated. Place a supplemental map number inside the appropriate rectangle. See figures 18 and 19 (p. 63).

Each sketch map should contain certain information, including a north arrow, scale expressed in both narrative (1 in represents 500 ft) and as a scale bar (

), and the site number.

Feature Related Characteristics

The next series of questions (10 through 18) refers to FEATURES. Complete one set of questions per feature. Prepare (photocopy) additional copies of this page for additional features at a given site.

Question 10

Question 10 (see Example 6) is **FEATURE.** This question asks for the identification of the feature under examination. Use one sheet per feature. Twenty-five specific major feature items are listed with space to list additional features. Place a check mark or an "X" in the box beside the term which best describes the feature under examination, or fill in the box labeled "Other." Features are reviewed in appendix I. Remember, only one feature per form.

It is important to know the total number of significant features at any given site. Thus, each feature visited should be given a number. Start with the number one (1) for the first feature and enter this in the box labeled "Feature Number." For the second feature visited, enter the number two (2). Add these numbers to the sketch map.

Feature identification is significant in the definition of possible environmental or physical hazards.

Example 6 shows a portion of the field form in which question 10 has been completed. Using the example of the Grizzly Bear Mine, two adits are observed during site reconnaissance. The first adit chosen for examination is open to entry. For the features question, mark "adit." Because this is the first feature visited, enter the number one (1) in the box labeled "Feature Number."

Question 11

Question 11 is **CONDITION**. For the identified feature, mark the phrase that best describes its condition, and determine if the condition of this feature represents a physical hazard. Circle **Yes** or **No**. Place a check or an "X" in the box beside the item that best describes the physical character of this feature. Choose from the list of 20 items or fill in the box labeled "Other." Accuracy of observation is critical because the answer will indicate what remediation is necessary. Most terms are self-explanatory. "Concealed" refers to the viewer's difficulty in seeing a feature. A pit fully overgrown with trees and bushes would be fully concealed. "Confined" refers to the presence of a retaining structure such as a tailings dam. "Subsidence" can refer to a depression around a wellhead, over a stope or glory hole, or broader area over a section of a mine, entire mine, or mining area.

In the Grizzly Bear example, question 11 (Example 6) is marked "Open to Entry." At the portal (entrance to the adit) some rocks have sloughed from the wall onto the floor of the adit. The presence of slough material is noted in the box labeled "Other." For this particular adit, accessibility implies relatively stable rock, but the slough material also implies some local weakness which could, in the future, represent a physical hazard; **Yes** is circled for the physical hazard question.

Question 12

Question 12 (see Example 6) is **SIZE OF FEATURE**. For significant features, indicate the size, measurement quality, and units, especially if this would aid overall description. This question is most often applied to mine dumps and mill tails. A row of three boxes is provided. In the first box give the length, in the second box give the width, and in the third box give the depth or height. Place a check or an "X" in one of the two boxes marked "actual" or "estimate" to indicate the quality of measurement; place an "X" in one of the two boxes marked "feet" or "meters" to indicate the units of measurement. Size estimates are acceptable. In the case of features such as adits, place **N/A** (not applicable) in the box labeled length as the length will be unknown without entry; however, if the length can be estimated, include this datum. The length of adit can often be estimated by shining a light down the adit. Also replace the word "depth" with "height" if the height of the adit is to be recorded and circle the appropriate word on the form. This question is also useful for giving approximate extent of subsidence around solution mining wells, thin ground over mined-out areas, mine dumps, and mill tailings. For highwalls, fill in height, slope (in degrees), and stability.

For the Grizzly Bear example, the feature is an adit with measurements of 4 ft wide by 7 ft high. These data are entered in their respective boxes, and "N/A" is entered for "length." Because this is not a "highwall," "N/A" is entered for "slope" and for "stability."

10) FEATURE Number [1] Fill out one form per feature. Check appropriate box below.

Adit [X]	Decline [ ]	Machinery [ ]	Ore Stockpile [ ]	Quarry [ ]	Stope [ ]
Building [ ]	Glory Hole [ ]	Mill Building [ ]	Pit, Large, >3 m [ ]	Shaft [ ]	Subsidence [ ]
Cistern [ ]	Highwall [ ]	Mill Tailings [ ]	Pit, Small, <3 m [ ]	Solution Mining Well [ ]	Sump [ ]
Crosscut [ ]	Leach Pad [ ]	Mine Dump [ ]	Placer Mine [ ]	Solution Pond [ ]	Trench [ ]
Other [ ]					Tunnel [ ]

11) CONDITION Does the condition of the above identified feature represent a physical hazard? Circle one. YES (circled) NO

Check the conditions that best describe the physical character of the above feature.

Breached [ ]	Collapsed, Partial [ ]	Empty [ ]	Foundation [ ]	Standing [ ]	Unstable Walls [ ]
Caved [ ]	Concealed [ ]	Eroded [ ]	Intact [ ]	Subsided [ ]	Wind Erosion [ ]
Caved, Partial [ ]	Concealed, Partial [ ]	Eroded, Partial [ ]	Open to Entry [X]	Unconfined [ ]	
Collapsed [ ]	Confined [ ]	Fenced [ ]	Rotten Cribbing [ ]	Other [Wall Slough]	

12) SIZE OF FEATURE Indicate size of feature and specify units (feet or meters).

Length [NA] x Width [4] x Depth or Height (circled) [7]

Measurement: Actual [X] Feet [X] Estimate [ ] Meters [ ]

Slope (Degrees) [N/A] Bank Stability: Stable [NA] Unstable [ ] Marginally Stable [ ]

13) WATER Is water present at the feature? Circle one. YES (circled) NO

Is water emanating from or passing through the feature? Circle one. YES (circled) NO

a) If water is present, how does it occur? Check all that apply.

Standing [ ] Filled [ ] Partly Filled [ ] Flowing [ ] Intermittent [ ]

b) If present, determine: GPM: [9.35] Conductivity: [300] pH: [6.5]

c) Observe water bed color. (Check all that apply, or specify other.)

Brown [ ] Green [ ] Yellow [ ] Yellow-orange [X] Orange [ ] Gray-black [ ] Other (specify) [ ]

14) PLANTS Are plants present on or around the feature? Circle one. YES (circled) NO

If yes, check one.

Healthy [ ] Stressed [ ] Dead [ ] Barren [ ] Partial Revegetation [X] Full Revegetation [ ] Other (specify) [ ]

15) STAINING Stains may indicate spills, oxidation, or alteration. Are non-water-related stains present? YES NO

If stains are present, check appropriate color or specify other. Yellow-orange [X] Gray-black [X] Other (specify) [ ]

16) MACHINERY Is machinery present at this feature? Circle one. YES NO (circled)

a) Location of machinery. Check all that apply.

Inside Building [ ] No Building [ ] Outside Building [ ] Other (specify) [ ]

b) Type of machinery. Check all that apply or specify other.

Amalgamation Equipment [ ]	Crusher(s) [ ]	Ore Bin(s) [ ]	Stamp Mill(s) [ ]	Vat(s) [ ]
Arrastre [ ]	Flotation Cell Group [ ]	Retort(s) [ ]	Tank(s) [ ]	
Ball Mill(s) [ ]	Leach Tank(s) [ ]	Rod Mill(s) [ ]	Thickener(s) [ ]	

Others (specify) [ ]

17) PHOTOGRAPH NUMBERS NONE

18) SKETCH NUMBERS NONE

COMMENTS

Water bed color represents bed color at portal.

Example 6.--Example of completed questions 10 through 18 and Comments section.

For the Grizzly Bear example, the feature is an adit with measurements of 4 ft wide by 7 ft high. These data are entered in their respective boxes, and "N/A" is entered for "length." Because this is not a "highwall," "N/A" is entered for "slope" and for "stability."

Question 13

Question 13 (see Example 6) is **WATER.** Presence of water is a significant item to note, and the condition of the water may indicate acid water drainage. The location of the observation is also important. Acidic water leaving an opening may be clear and not produce or precipitate yellowish ferrous oxyhydroxide or other substances for some distance from the opening. Therefore, include the location of the observation in the comments section and on the sketch map. This question is composed of three parts and three observations. First: "Is water present at the feature?" Circle **Yes** or **No.** If yes, continue, otherwise go to part "c." The second part is, "Is water emanating from or passing through the feature?" Circle **Yes** or **No.**

Assuming water is present, the investigator is asked to make three observations. The third observation applies to areas with water or that may have water at some time of the year.

Part "a" is: "If water is present, how does it occur? Check all that apply." Five choices are listed: standing, filled, partly filled, flowing, and intermittent. Choose all that apply and place a check or an "X" in the box beside the choice.

Part "b" asks for three measurements. "If present, determine gpm (gallons per minute); conductivity, and pH." Gpm is the flow rate in gallons per minute; conductivity is the ability to pass electricity; and pH refers to acidity or basicity. These measurements are good indicators of possible environmental hazards, including acid water. For each, place the value in the appropriate box.

Flow Rate

For low-discharge sites, flow rate can be measured by simply measuring the amount of time taken to fill a known volume in a bucket. For higher flow sites, discharge can be estimated by using a floating object such as a twig. Find a relatively straight section in the water channel, preferably 0.9 m (3 ft) long, and determine the average width and depth. Place the floating object in the channel above the starting point of the straight section and record the time it takes to pass through the section. Calculate gallons per minute as follows:

$$\frac{60 \text{ sec/min} \times \text{length (in inches)} \times \text{average width (in inches)} \times \text{average depth (in inches)}}{(231 \text{ in}^3/\text{gal}) \times \text{time (in sec)}}$$

or

$$(0.26) \times \frac{\text{length} \times \text{width} \times \text{depth}}{\text{time}} = \text{gpm}$$

Specific Conductivity

Conductivity is the measurement of the amount of electricity that will pass through something. In this text, specific conductivity is applied to water. Generally speaking, as the amount of total dissolved solids (TDS) increases in water, the specific conductivity increases. The TDS can be a function of a variety of factors and may or may not by itself indicate a problem. TDS can be measured either as weight of solids per unit volume (milligrams per liter [mg/L]), or as a function of electrical conductivity (microsiemens [um]). Natural "fresh" water, uncontaminated by metals, can have a TDS from near zero up to 1,000 mg/L. Brackish water may have TDS as high as 10,000 mg/L. Contaminated mine drainage waters can contain from several hundred to several thousand milligrams per liter TDS. To collect the data, insert the instrument sensor into the water and record the reading. Carefully follow the manufacturer's instructions.

pH Measurements

In this text, the term "pH" refers to the acidity (negative log of the hydrogen ion concentration) of water and ranges from 0 to 14 with 0 being very acidic, 14 very basic, and 7 neutral. Most natural surface water has a pH between 6.5 and 8.5. Natural ground water pH usually ranges between 6.0 and 8.5. Measurement of the water's pH, using either a probe and meter or proper litmus paper, will indicate whether the water presently is acidic. Water with a pH of less than 5.5 is of concern.

pH probes with direct digital readout are readily available, inexpensive, and relatively easy to use. Some need calibration with a standard solution before each use while others do not. In either case, dip the probe into the water and record the reading. Litmus paper dipped in the water will display a color related to the pH; this color is compared to a chart and an estimate of the pH is read. Litmus papers can be obtained in several pH ranges (e.g., 4-11, 6-8, 6.5-7.5). A variety is often needed.

The choice of pH measuring devices depends on several factors, including operator knowledge, time, and economics. If a pH meter is used, carefully follow the manufacturer's directions.

Part "c" asks: "Observe water bed color." There are two media which may have color and the two should not be confused. Water which is cloudy (carrying suspended particles) will have a certain color. However, if the water is clear, the color of the material over which the water flows will be observable. This latter material is the water bed. The color of this material can assist in determining if the water poses an environmental hazard. The bed color may be the "natural" color of the rock indicating no apparent precipitation, or the color of precipitates which have coated the water bed material. If the water is cloudy, note both the presence of cloudiness and the color in the comments box at the end of the form. In dry climates, water may not be present, but stains may still occur on dry water beds. Look for water courses and stains in both wet and dry climates.

Look at the water bed color and choose one of the listed six colors. If the observed color is not listed, fill in the box labeled "Other."

In the Grizzly Bear Mine example (see Example 6), water is present at the site so the first question in the water section is answered **Yes**. Water is flowing from the adit, so the second question "Is water emanating from or passing through the feature?" is also answered **Yes**. Part "a" is marked "Flowing" because water is flowing from the adit.

Three measurements are collected, gpm, conductivity, and pH. The water from the adit flows in a channel about 6 in. average width, and about 2 in. average depth. A piece of twig placed in the water traveled 3 ft in 12 sec. Using the above formula, a flow rate of 9.35 gpm was calculated.

Both pH and conductivity readings are collected (pH = 6.5 and conductivity = 300) and entered into the appropriate boxes. The water bed color is observed to be yellow-orange, so an "X" is placed in the box beside the color yellow-orange. The water bed color was noted as the water left the portal. This information is entered in the "Comments" section. This completes question 4.

Question 14

Question 14 (see Example 6) is **PLANTS**. Specifically, "Are plants present on or around the feature?" Answer by circling either **Yes** or **No**. If yes, continue and place an "X" or check in the appropriate box provided or fill in "Other." The answer has two parts, the health of the plants, and the relative abundance. If plants appear healthy but are fewer in number than on surrounding soil, mark "Healthy" and "Partial Revegetation."

Plants may show stress by being more yellow than similar plants in surrounding areas, or may be droopy, or pale in color. Stress may be produced by lack of water, poor soil, compact soil, or toxic materials. If possible, also note if plants appear to be a similar or different type compared to those areas generally surrounding the site. Note this information in the "Comments" section. Do not confuse plant death from stress with plant death due to natural seasonal changes.

Some plants are more tolerant of metals than other plants. Geo-botanical prospecting uses this phenomena in the search for metallic deposits by looking for those specific plants which "thrive" on high metals soils relative to other plants. These plants (depending on which part of the United States the inventory is taking place) should be noted and utilized as a possible indicator of heavy metals.

For information on a particular ecoregion or for a specific mine area, contact the local Forest Service office or BLM district office. These agencies can often furnish information regarding vegetation types and classifications and listings of sensitive, threatened, and endangered plants.

In the Grizzly Bear Mine example, a few healthy green plants are growing next to the portal of the adit, near the water. In example 6, the answer **Yes** is circled, and an 'X' is placed in the box next to "Healthy." Because only a few were present, "Partial Revegetation" was marked.

Question 15

Question 15 (see Example 6) deals with **STAINS**. Specifically, "Stains may indicate spills, oxidation, or alteration. Do stains occur on rocks, foundations, or other non-water-related features?" Circle **Yes** or **No**. If yes, check the appropriate color or specify the color if not listed.

Question 15 addresses several concerns. If sulfides are present in the rock they may oxidize and form a yellow-orange stain. This could be an indicator of possible acid generation. Gray-black (possibly brown) stains are most commonly associated with petroleum products used in gas- or diesel-powered equipment. If these products are spilled, they often leave a stain. Some chemical stains also may be yellowish to yellow-orange in color.

In the Grizzly Bear Mine example, a faint orange stain on some of the rock next to the entrance to the adit is observed. On the ground nearby is an odd gray-black stain. From the pre-field work it was determined that the mine operated after 1920, so gasoline or diesel power may have been used. Both stain colors should be noted. As shown in Example 6, **Yes** is circled and an "X" is placed in the box beside both "Yellow-orange" and "Gray-black."

Question 16

Question 16 (see Example 6) is **MACHINERY**. Specifically, "Is machinery present at this feature?" Answer by circling **Yes** or **No**. If yes, continue to part "a," location of machinery, and part "b," type of machinery. For example, if the feature is a mill with the remains of mill equipment, question No. 1, "feature" would be marked "mill building," and question 16 would be marked "yes" machinery is present. Parts "a" and "b" would then be completed.

For part "a," determine the location of the machinery and check all that apply. The choices are inside a building, outside a building, no building, and other. Check, or place an "X" in the appropriate box or fill in "Other."

In part "b," place a check or an "X" in the appropriate box beside the general type of machinery present. Check all that apply. If the device is not listed, fill in the blank box labeled "Other."

The Grizzly Bear Mine has some remains of machinery near an old mill building but no machinery of any type visible at the portal. The answer **No** is circled because the feature under examination is an adit with no visible machinery.

Questions 17 and 18

Question 17 is **PHOTOGRAPH NUMBERS**; question 18 is **SKETCH NUMBERS**. These questions are to be answered in the same general way as questions 8 and 9, respectively.

Comments

Use the Comments section to add specific notes.

Supplementary Data

Part III of the AML Inventory form is a gridded sheet to be used for a sketch map of a site, section of a site, or local feature. At the top of the page are four boxes labeled "Site Number, Sketch Number, Page _ of _, and Date." Fill in each box appropriately if a sketch map is drawn. On the map, place a text scale (1 cm or 1 in. represents a given distance, meter or feet, on the ground), a bar scale, and a north arrow showing the direction to north.

Task 5--Review Form and All Data Sets for Completeness

Review the entire form for completeness. Review all notes, pictures, and data to be sure you have everything necessary to adequately describe the feature. This feature is now complete and you are ready to proceed to the next feature.

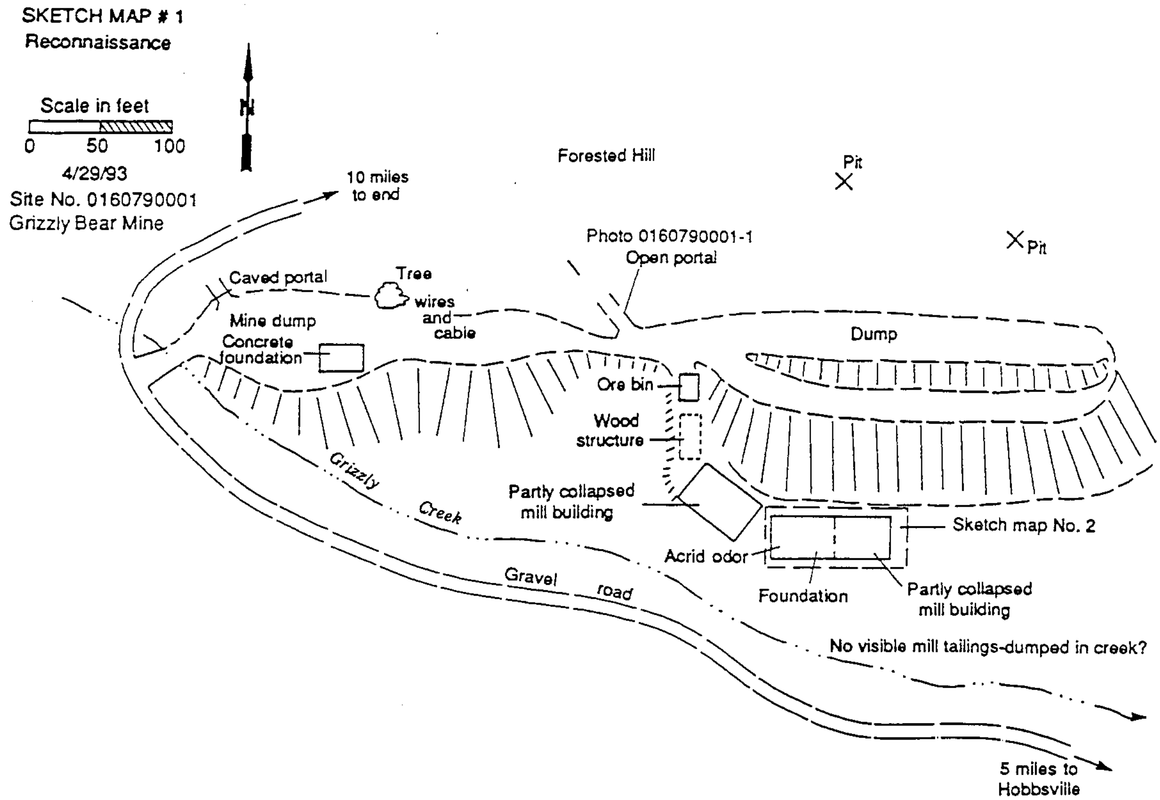


Figure 18.--Example of a site sketch map which shows general area and location of dumps, buildings, and other significant features.

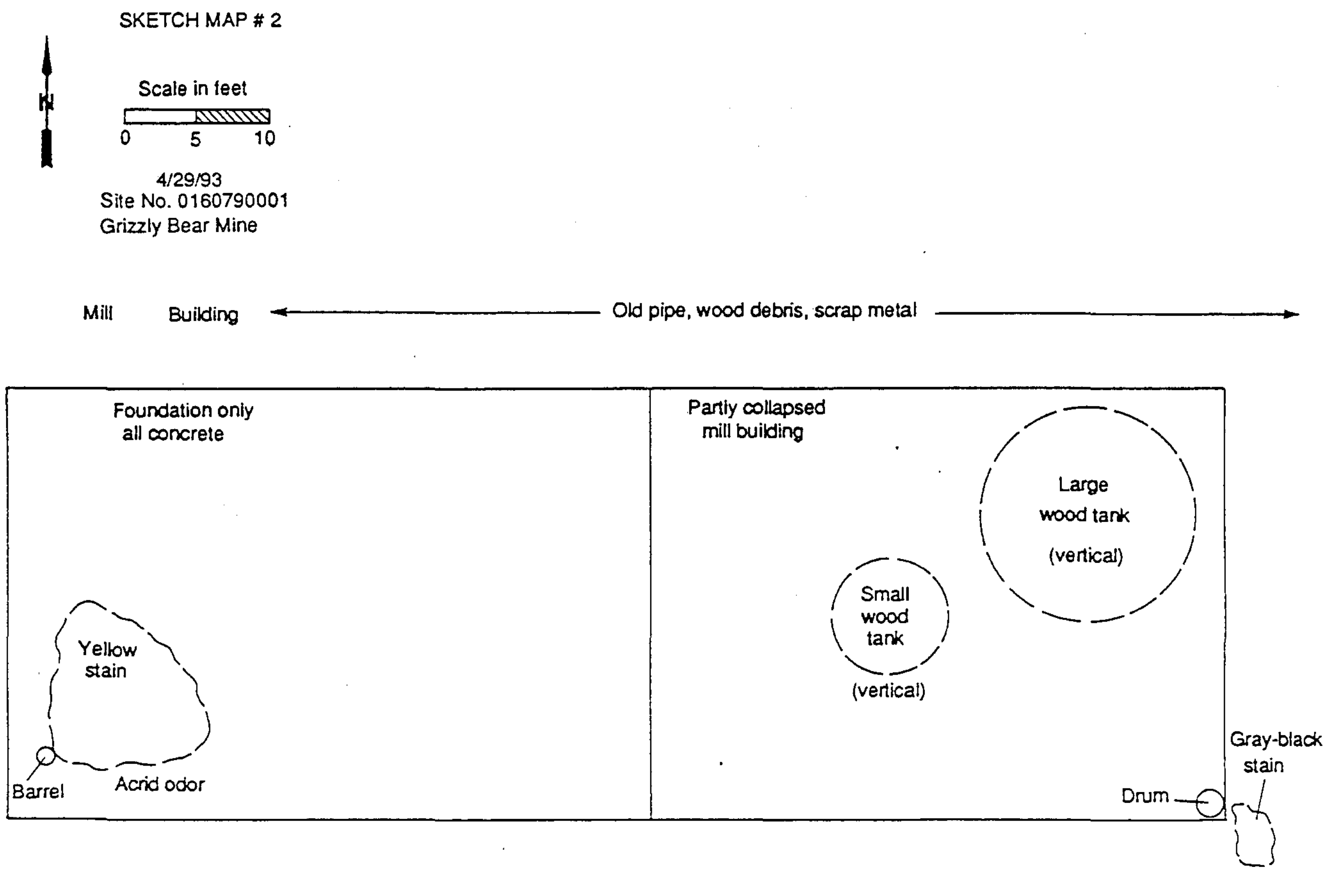


Figure 19.--Example of a large-scale sketch map showing a selected portion of a site.

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CHAPTER 8

STEP IV--IDENTIFICATION OF SITES REQUIRING FUTURE ACTION

Field data evaluation is the next step to determine which sites warrant additional attention. The Pre-Field and Field Data forms (and supplementary data), photo(s), map(s) and sketch(es) for each site contain data relating to two types of hazards, physical and environmental. Physical hazards usually are easier to visually identify than are environmental hazards. The physical and environmental hazards at each site should be evaluated separately. The following discussion gives some general guidelines for evaluation of the data.

IDENTIFICATION

Physical Hazards

Any item listed in question 1 of the field form can represent a physical hazard, depending upon its condition. Physical hazards can be grouped into three general categories: airborne, ground, and water related. Use question 1 **(FEATURE)**, question 2 **(CONDITION)**, question 8 **(MACHINERY)**, question 11 **(EXPLOSIVES)**, and question 12 **(OTHER)** on the field form to aid in defining physical hazards. Question 10 **(HUMAN ACTIVITY)** can be used as a 'screen' to aid in relative ranking of physical hazards. The same hazard will be more significant near areas of heavy human use or activity.

Airborne hazards are those that could affect air travel and include wires, cables, power lines, and tram lines. These are especially dangerous to helicopters. Ground hazards represent the largest group. This group can include adits, cisterns, tunnels, quarries, declines, sumps, shafts, buildings, glory holes, machinery, and highwalls. Some, such as shafts, are by their very nature, dangerous. If they have soft collars, are covered by wood and dirt, or are concealed by vegetation, they become even more dangerous. Some features are physical hazards only under certain conditions. These conditions include partial collapse, partly caved, rotten cribbing, unstable walls, and subsidence. For example, an adit open to entry or completely caved may be of less risk than a partly caved adit. Partly collapsed buildings also are a physical hazard. The third group is water related. This group could be included in the ground hazards, but is separated here for emphasis. If water fills a feature, it becomes more of a hazard than without water. For example, a foundation may be of little physical hazard, when dry, but a considerable physical hazard when full of water.

A few physical hazards may require emergency response. For example, if explosives or blasting supplies are discovered at a site, this would require an emergency response to remove these items.

Environmental Hazards

Environmental hazards are more difficult to evaluate than physical hazards. Data collected on the field form will provide general guidance as to whether additional work is necessary, but **WILL NOT PROVIDE FINAL ANSWERS AS TO THE TOTAL EXTENT OF ENVIRONMENTAL HAZARDS PRESENT.** A total environmental hazard assessment can only be accomplished through site characterization. To determine if a possible environmental hazard is present, use information from questions 10 **(FEATURE)**, question 3 **(WATER)**, question 14 **(PLANTS)**, question 15 **(STAINING)**, question 5 **(RADIATION)**, and question 7 **(OTHER)**.

When evaluating a site for environmental hazards, two questions should be asked: "Does this site warrant additional work?" and, "Is any of that work an emergency response?"

Certain observations indicate the need for additional work (site characterization). These include: breached tailings dams (potential sedimentation of creeks, streams and lakes); unconfined tailings; eroded tailings; flowing water from, over, or near an adit, large pit, mine dump, ore stockpile, mill tailings, leach pad, or solution pond; water with a pH of less than 5.5; water with a conductivity of greater than 1,000 microsiemens; water bed with colors of yellow, red, yellow-orange, or orange; stressed plants; yellow-orange or gray-black stains on rocks, foundations or other non-water-related features; radiation readings above 500 cps; and the presence of certain machinery such as ball mills, rod mills, vats, flotation cells, amalgamation equipment, retorts, leach tanks, stamp mills, and thickeners, which imply that cyanide, mercury, or other processing chemicals could be present.

A second group of features not only indicates the need for additional work, but may indicate the need for an emergency response. These include: bags or drums of chemicals or containers in which chemicals have been stored, and transformers that may contain polychlorinated biphenyls (PCB's). Tanks associated with the milling process (if full or partly full), or leach ponds with liquids, also may require an emergency response.

CHAPTER 9

FUTURE ACTIONS

When the AML inventory/evaluation phase has been completed, and sites that warrant additional attention other than emergency response have been identified, it is time to move on to the next two phases: site characterization and remediation. These phases result in the elimination of public safety and environmental hazards and usually are handled by specialists. An overview is presented in this section.

ELIMINATION OF PUBLIC SAFETY HAZARDS

For physical hazards, the site characterization phase of the AML process is unnecessary, and the investigator can move directly to the remediation phase. There are a number of options available for the remediation of physical hazards, and they range from temporary to permanent and from inexpensive to expensive. A detailed discussion of each is beyond the scope of this handbook; however, a generalized list would include:

° Temporary mine opening closure - fences, cable nets, gates, grates.
° Intermediate mine opening closure - concrete caps, plugs, bulkheads.
° Permanent mine opening closure - backfill, burial, blasting.
° Mine roads, quarries, pits, waste piles - burial, recontouring, revegetation.
° Structures - controlled burns, stabilization, demolition.
° Equipment - removal, disposal, burial.
° Chemicals, explosives - destruction, removal.

ELIMINATION OF ENVIRONMENTAL HAZARDS

Site Characterization

Site characterization is conducted at those sites selected in Step IV above as having or potentially having serious environmental problems. Site characterization involves detailed examination of a site to accurately define the nature and extent of contamination and the risks to the environment and human health.

Mining and minerals-related sites can be very complex physically and chemically due to the broad spectrum of ore types, processing techniques, mining methods, and metal recoveries that were emphasized during the life of an operation. Traditional site characterization methods are often ineffective for large-volume mining wastes containing generally low, but highly variable, metal contents. This is especially true in mining districts which have high levels of naturally occurring metals. Hence, the quantities and areal distribution of contaminated material, the exact nature of contamination, and the risks posed by the contamination are frequently inadequately defined. This could lead to costly and ineffective remedial decisions and actions. Effective characterization of mining sites clearly needs specialized methods tailored to these unique problems.

In response, the USBM established the Mine Site Characterization Program. USBM experience indicates that the basic problem--what is there and how much is there--is fundamentally similar to the process of mineral discovery and lends itself to adaptations of techniques used by the USBM and industry for mineral exploration and resource evaluation. Accordingly, the Program is producing mine-site-specific characterization procedures, risk assessment protocols, and cost estimating systems. Developed methods and technical assistance are available upon request to government agencies dealing with AML problems.

In general, site characterization studies usually are organized by environmental media and major concerns, such as illustrated in the example matrix below. Specific studies rely on geophysical, geochemical, biological, mineralogical, geohydrological, and geostatistical approaches and techniques.

Recommended Studies

Concerns	Waste Piles	Soil	Water	Vegetation	Wildlife
Acid drainage	X	X	X		
Stressed/absent vegetation	X	X	X	X	
Erosion/sedimentation	X		X		
Threatened/endangered species ..			X	X	X
Frequent human presence	X	X	X		
Chemicals..	X	X	X		

Remediation

After site characterization has fully defined the problem, options for correcting the problem and remediation alternatives need to be evaluated. This phase requires considerable flexibility and objectivity to ensure that all significant concerns are addressed, that the unique aspects of individual sites are recognized, and that cost/benefit ratios are adequately considered.

As stated earlier, mining and mineral-related sites can be very complex physically and chemically. Thus traditional approaches to remediation may not be completely effective, or, as is the case with removal or vitrification of large waste piles, may be prohibitively expensive.

In response, the USBM established the Environmental Technology Research Program to address the remediation solutions required specifically for mining sites. Efforts are centered on development of technology that supports reprocessing of past wastes, decontamination of leach piles, treatment of acid mine drainage, detoxification of metallurgical wastes, and mitigation of damage caused by mine subsidence. The results of these efforts are available upon request.

In general, remediation can involve one or more of the following:

- Containment - caps, revegetation, dams, grouting, backfilling.
- Water treatment - reagents, wetlands, diversion, biochemical methods.
- Material treatment - reagent injection, reprocessing.

The primary deciding factors usually are cost, effectiveness, and time frame for remedy. Also, as was the case with site characterization, the choice of methodologies must be done in reference to the ambient (natural background) levels in the environment.

CHAPTER 10

CONCLUSIONS

By the time an investigator has reached this part of the handbook, he or she has seen how to conduct an AML inventory and evaluation by (1) developing an initial list of AML sites, (2) selecting sites for field investigation, (3) conducting site investigations, and (4) identifying sites that require future actions. The user also has obtained an overview of site characterization and remediation. The investigator is now in a position to make, or assist with, planning and implementation decisions on AML hazard identification and mitigation.

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CHAPTER 11

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